Te Awa O Kātāpaki & River North

Integrated Catchment Management Plan

Status: FINAL

July 2024

Revision No.	Date	Status	Authorised (ICMP)	Approval
1	30/11/2023	Final for WRC Certification		
2	04/03/2024	Final for WRC Certification		
3	31/07/2024	Final	Waikato Regional Council Certification	
			Nathanael Savage – Project Sponsor	

Hamilton City Council

Integrated Catchment Management Plan

CONTENTS

APPENDICES

TABLES

FIGURES

Abbreviations

BPO	Best Practicable Option
BPR	Best Practice Requirement
CSDC	HCC Comprehensive Stormwater Discharge Consent
CPTED	Crime Prevention through Environmental Design
GRMP	HCC Gully Reserves Management Plan
HCC	Hamilton City Council
ICMP	Integrated Catchment Management Plan
LOS	Levels of service
MCA	Multi Criteria Assessment
NAMTOK	Nga Manu Toopu O Kirikiriroa
ODP	HCC Operative District Plan
Proj Water Watershed)	Waikato River Catchment Services – Level of Service and Funding Policy (Project
RITS	Regional Infrastructure Technical Specifications (replaces ITS)
RPS	WRC Regional Policy Statement
RRMP	HCC Riverside Reserves Management Plan
SP	Structure Plan
Sust Strat	HCC Environmental Sustainability Strategy
SWMP	HCC Stormwater Management Plan
THaWK	Te Haa o te Whenua o Kirikiriroa
TP10[1]	Auckland Regional Council Technical Publication 10 – Stormwater Management Devices
WDC	Waikato District Council
WRA	Waikato-Tainui Raupatu Claims (Waikato River) Settlement Act
WRC	Waikato Regional Council
WRP	Waikato Regional Plan
WWPS	Wastewater Pump Station

[1] When the ICMP was originally drafted, the Waikato Stormwater Guidelines were under development. They have since been finalised and should be read as a replacement reference to TP10 in this document.

Executive Summary

The development of this Integrated Catchment Management Plan (ICMP) has spanned 14 years and commenced in 2006. The ultimate focus of this ICMP is the restoration of the Te Awa o Kātāpaki Stream and contributing catchment. In order to achieve that, this document provides guidance on how stormwater, wastewater and water supply is to be managed considering current and future land use in the Te Awa o Kātāpaki and River North catchments as Hamilton expands into the Rototuna Structure Plan area.

During the development of this ICMP the legislative framework has changed several times. Such changes include the recent introduction of the National Policy Statement for Freshwater Management (2020), the Hamilton City Stormwater Master Plan version 2 (2020), the development and subsequent updates to the Waikato Regional Council stormwater management guidelines (2020), and the updates to the Hamilton Infrastructure Technical Specifications (now Regional Infrastructure Technical Specifications (2019)). Best practice for stormwater management has continued to evolve, as well as Council's knowledge of the catchment, performance of existing devices and localised changes in ecological characteristics.

The Te Awa O Kātāpaki catchment covers an area of approximately 770 hectares and the adjacent River North catchment covers approximately 108 hectares. The Te Awa O Kātāpaki stream has a range of reach types including artificial drains, on-line stormwater devices (Bourn Brook swale, Magellan Lake), modified stream channels (Tuirangi Canal, and Petersburg Drive Lake) and the natural vegetated gully and stream channel downstream of Magellan Lake.

Structure Plan land within the Hamilton City area of the catchment is zoned for urban development (General and Medium Density Residential zones), a suburban community/commercial node and major transport infrastructure (Waikato Expressway) servicing the local area. A substantial amount of development has already been consented by Hamilton City Council (approximately 90% of the catchment) and at least 70% of the catchment has already been developed.

The preparation of this document has also spanned many years. Several technical assessments have been developed to support this ICMP and stormwater guidelines, and Council has drawn on early draft ICMP outputs to inform consented development as it progressed. Meanwhile urbanisation in the catchment continues at pace. More recently, new assessments have been produced which have reviewed existing stormwater management devices, updated ecological assessments and annual catchment monitoring, and reviewed previous flood hazard models. These inputs have been used to update findings of historical assessments previously relied on during earlier drafts of the ICMP and to reflect the current legislative framework.

In the interest of providing succinct summaries of key residual issues, and without losing previous detail from earlier versions, a summary table is provided at the beginning of each main chapter. Supporting technical information is retained in the chapters, however, may reflect earlier assessments which were not the subject of recent updates.

Key and residual issues in the catchment include;

- **water quality and treatment**
- **cultural heritage**
- **in-stream erosion and scour prevention**

- **flood hazard management and stormwater attenuation**
- **protection of key overland flow paths**
- **watercourse, wetland restoration and ecological enhancement**.

These are summarised as follows:

Table 0 – Key Residual ICMP Issues, Mitigations and Conclusions		
Water Quality	**Key mitigations**	**Conclusions**
1. Historic brownfield development did not require stormwater management until 2000, resulting in a portion of the catchment without treatment.	1. Redevelopment will need to meet the current standards to achieve catchment outcomes and retrofit devices will be required.	1. Development standards are clear in the means of compliance table for new development, and a new brownfield devices programme is proposed in the LTP[2].
2. An update to Hamilton's Infrastructure Technical Specifications (2013) resulted in preferred stormwater treatment generally changing from ponds to wetlands; new development will reflect current standards. Older devices do not meet current standards.	2. Prioritisation of improvements to existing stormwater devices.	2. Existing/older devices are prioritised for improvement in the existing device upgrade programme. Some improvements can occur under defects liability and regular maintenance. New devices are in some cases supported by LTP[2] funding.
3. The ICMP recommends additional water quality measures in some sub catchments to support downstream devices (e.g. Bourn Brook swale in Rototuna).	3. Additional at source recommendations, including a recording and monitoring programme	3. Development standards are clear in the means of compliance table.
4. HCC's Stormwater and Receiving Environment Monitoring Programme will continue.	4. Inclusion of an additional monitoring site in Council's SREMP, upstream of Resolution Drive	4. Additional site added to the existing environment monitoring programme.

[2] These projects are all subject to Long Term Plan funding and prioritisation.

5. Public education regarding edible aquatic plants and fish harvesting (i.e. where watercress collection may occur).	5. Proposed signage (at Magellan Lake) for public education regarding harvesting of fish and aquatic plants for consumption within the catchment.	5. Enhanced public awareness regarding harvesting of flora/fauna for human consumption.
Cultural Impacts	**Key mitigations**	**Conclusion**
1. A Cultural Impact Assessment prepared for the Rototuna Structure Plan (NAMTOK, 2005) has described tangata whenua historic use and occupation in the wider structure plan area. Of note are several borrow sites and pre-European sites along the banks of the Te Awa o Kātāpaki stream. Increased erosion and scour are anticipated in the stream and works to stabilize these high-risk areas may impact on known and unknown archaeological sites.	1. City wide inventory and mapping of archaeological sites and sites of cultural significance updates earlier investigations (District Plan Change 9 - 2021). 2. Undertake specific archaeological assessment on lower reaches of the Te Awa O Kātāpaki stream where erosion protection works are proposed. 3. On-going engagement and cultural monitoring of sites of significance during erosion protection works. 4. Application of Heritage NZ archaeological authority conditions (if any)	1. Increased awareness and engagement with mana whenua regarding known and previously unknown archaeological sites, coupled with obtaining necessary archaeological authorities will complement the existing and historical traditional knowledge and occupation within the catchment. 2. Assessment of risk to these sites can be confidently undertaken ahead of Council's proposed erosion protection works.
Erosion and Scour Prevention	**Key mitigations**	**Conclusion**
1. Stormwater volumes and run-off from the catchment into the stream, coupled with instability of stream reaches in key locations (between Magellan Lake and Petersburg Drive) are contributing to downstream erosion and bank scour. A programme of erosion prevention works has been developed in response to these issues.	1. Prioritisation and implementation of erosion prevention works by City Waters.	1. Te Awa o Kātāpaki Catchment Erosion Control programme to minimise the effects of increased volume and downstream erosion. Funding in accordance with LTP[2] allocation.
Flood Hazard and stormwater attenuation	**Key mitigations**	**Conclusion**
1. Stormwater modelling has been completed and the catchment reflects good urban	1. Engagement with landowners regarding flood hazard GIS viewer and impact of modelled	1. Flood levels will be contained largely within gully and stream network

design with flooding generally limited to designated drainage channels and road reserves as per accepted practice. 2. The modelled estimates are conservative and can be considered with any new development and can be applied to development of centralized stormwater attenuation devices in greenfield areas. 3. Flood modelling results indicate a small number of properties may become impacted by flood hazard based on effects of climate change and conservative infill development assumptions.	flooding in the catchment, flood data has been made publicly available 2. Centralised attenuation devices in greenfield areas will result in no more than minor effects of development on the existing flood hazard, with some devices requiring flood attenuation. 3. Proposed flood attenuation, to the maximum reasonable extent in greenfield areas protects people and property from existing and future flood risk, accounting for the effects of climate change.	(except for minor encroachment of flood extents, and below existing building platforms). 2. MPD 100yr flood + climate change in the catchment will result in no more than minor effects and will not exacerbate existing catchment flood hazard. Means of Compliance table is clear about which catchments require flood control. 3. Flooding increase in brownfields is less than minor. 4. Flood management programme to address brownfield flooding issues approved as part of LTP[2].
Overland Flow paths	**Key mitigations**	**Conclusion**
1. GIS mapping identification of overland flow paths shows major overland flow paths requiring formation and protection.	1. Identification and protection of the key overland flow paths in the catchment at the time of resource consent. 2. Properties south of Borman Road may require protection from overland flows in the event of pipe blockage.	1. Existing overland flow paths will be protected from build-out. 2. Key OLFP flood management projects have been funded in the LTP[2].
Ecology	**Key mitigations**	**Conclusion**
1. Watercourse and wetland classification mapping has been completed in the TAOK catchment. Nine areas have been classified as possible natural wetlands.	1. Further assessment of the 'possible natural wetlands' in the upper catchment will enable effects of development to be assessed against the National Environmental Standards for Freshwater Regulations 2020.	1. Means of compliance table clearly requires the identification the protection of historic and remnant natural wetland areas in the catchment.

2. The catchment is home to a number of native fish species including shortfin and longfin eels, banded and giant kōkopu, smelt, and black mudfish. Few sensitive taxa/species are encountered in samples, including in the parts of the stream with good physical habitat quality.	2. Improvements to existing stormwater devices, implementation of in-stream and riparian enhancement works.	2. Gully Restoration and Development Programme of habitat restoration and enhancement is underway.
3. Turbidity and suspended sediment are at concentrations that cause avoidance behaviour in fish and reduction in aquatic macroinvertebrate diversity, while increasing particulate metals and nutrient loads discharged into the aquatic habitat.	3. Strengthening the effectiveness of erosion and sediment control measures on construction sites.	3. The existing device upgrade programme to prioritise improvements to stormwater devices.

Water Supply and Wastewater

Hamilton City Council's Water Master Plan is the overarching plan for the development of major water infrastructure. Water supply for new development is supplied by the Rototuna reservoir and associated bulk mains which were completed in 2018. Strategic trunk mains will continue to be installed as further development occurs in accordance with the ICMP.

While Level of Service (LOS) for the water network is not likely to be a problem, water conservation, non-revenue water and demand management measures will always need to be considered and implemented to ensure resilient and cost-effective network citywide.

Hamilton City Council's Wastewater Master Plan is the overarching plan for the development of major wastewater infrastructure. All the major pump stations and rising mains have been constructed in the catchment and there are no significant wastewater network constraints. Trunk sewer extensions (Borman Road east) and the construction of local collection pipelines are required to serve development as it occurs.

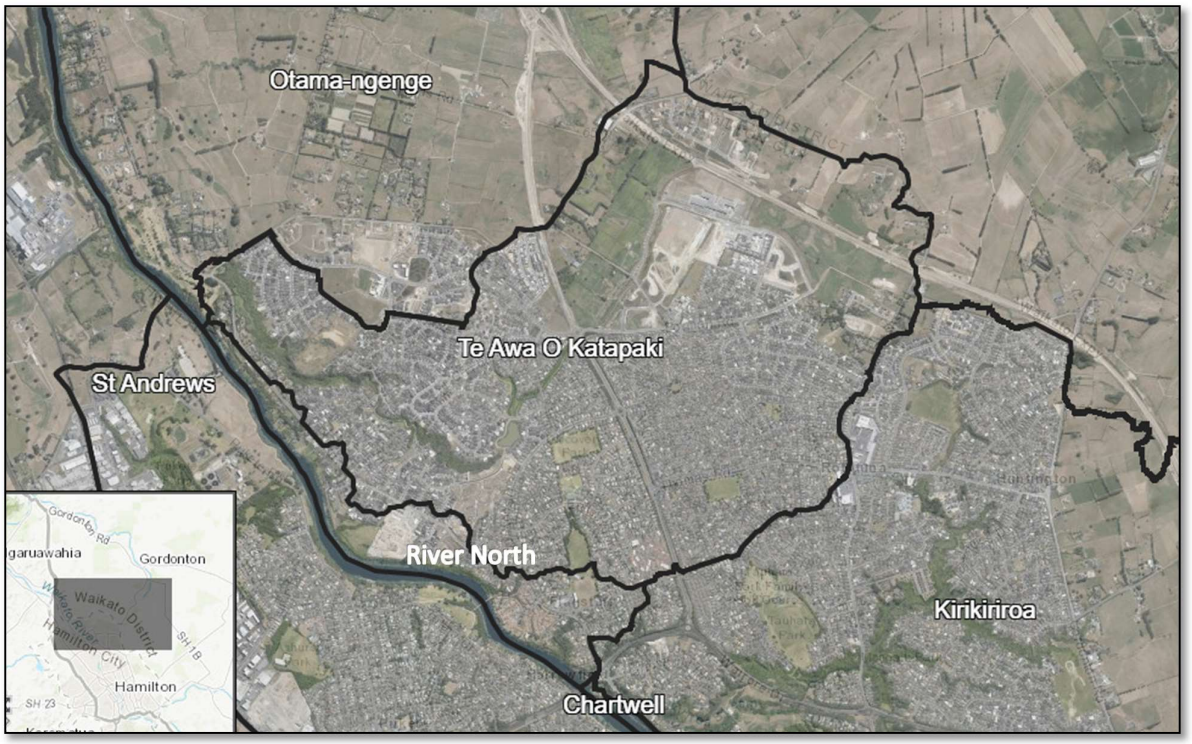


Figure 1 – Te Awa O Kātāpaki and River North catchments

Implementation

Parameters have been defined to direct stormwater management requirements during development. These are described in Section 12.2 (Discharge Parameters) and Section 13.2 (Means of Compliance with ICMP Objectives). A description of ICMP Implementation is provided in Section 11 and proposed requirements for catchment monitoring is provided in Section 14. Future actions and opportunities have also been identified in Table 15-2 and a programme of work has been put forward (subject to LTP funding decisions). The programme of works will be part funded by developers, and part funded by Council and others, with the split to be determined through the LTP process.

Summary of Te Awa o Kātāpaki Integrated Catchment Management Plan Development

The Te Awa o Kātāpaki Catchment Management Plan was initiated in 2006. Concurrently Hamilton City Council was applying for its city-wide Comprehensive Stormwater Discharge Consent, which included a requirement for the creation of greenfield Catchment Management Plans (CMP) across the City. In 2017, the operative DP required Integrated Catchment management plans to help integrate the 3 waters infrastructure on a catchment wide basis.

A series of catchment specific investigations for the ICMP as it is now currently known recommenced in 2013 to respond to comprehensive Stormwater Discharge Consent. This included stormwater modelling by Aecom, followed by several other investigations in 2015.

Further revisions of the ICMP in 2017 led to additional investigations into erosion costing and additional stormwater modelling. A peer review of the stormwater modelling by Beca was undertaken in 2017, at the same time Council was reviewing its city-wide approach to managing and communicating flood hazards in this and other catchments. Engagement with key stakeholders in 2019 (including tangata whenua, Waikato regional Council and internal HCC staff) has culminated in the current draft 2020. This recent draft has been supported by three further assessments (water quality and device performance, ecological review and stormwater device and flood hazard review).

Technical investigations that have informed the final draft ICMP are summarised in the table below:

Technical Assessment/Report	Author	Commentary
Receiving Environment Ecological Assessment and Walkover	Boffa (2015)	HCC has prepared an erosion prevention programme and projects to be progressed are being prioritized through the HCC erosion control programme. Ecological enhancement programme is underway by HCC (Lake Magellan) Ecological sampling between 2014-2017
Hydrogeology/Geotech	T&T (2015)	
Water course assessment	Morphum (2017)	
Review of Freshwater Ecological information	T&T (2021)	T&T completed a review of historic and recent ecological assessments in the catchment and recommended additional actions.
Wetland Classification (as per NPS FW)	T&T (2021)	T&T completed a wetland classification of the upper catchment as per NPS FW.
Contaminant Load Modelling	Aecom (2015)	No updates
Flooding and OLFP Stormwater Modelling Existing Development	Aecom (2013)	All flooding and OFLP modelling was undertaken by Aecom between 2013-2017.
Existing Development +Maximum Probable Development	Aecom (2015)	
Additional scenarios	Aecom (2017)	

Peer Review	Beca (2017)	Peer review undertaken by Beca 2017.
Summary of issues	Beca (2020)	Beca (2020) completed a summary of modelling process to support and update the ICMP document since 2017 (refer chapter 4).
Primary Network Water and Wastewater reticulation	Aecom (2015)	No update
Stormwater Devices Morphum – existing/brownfield	(2020)	Partially completed under Stormwater Master Plan v2 where several devices in the catchment were inspected. Further review of remaining brownfield devices completed, and remedial works costed and prioritized (via an MCA approach)
Review of existing consents - quantity	Beca (2020)	Beca review to clarify compliance with flood attenuation requirements only.
Cultural Impacts Rototuna Town Centre CIA	NAMTOK CIA (2006)	Archaeological assessment recommended (Sian Keith Associates Ltd) to inform extent of archaeology that could be impacted by HCC City Waters erosion prevention works.
District Plan Review	City Planning (2021)	City wide review and mapping of archaeological sites. Cultural sites of significance separately undertaken by mana whenua
Growth	ICMP	No assessment undertaken, refer ICMP for commentary on growth in the catchment
ICMP Drafting V.1 Aecom	Aecom (2015-2018)	ICMP commenced with Aecom preparing first drafts to December 2019.
V.1.1 (HCC)	HCC (2019)	HCC progressed internal communications and prepared for external engagement
V.2 (HCC/Beca)	HCC/Beca (2020-2021)	Beca on behalf of HCC has undertaken further engagement with key stakeholders, responded to feedback and revised isolated sub-sections of the ICMP since 2019 to reflect the updated Stormwater Requirements concurrent with HCC's GIS Webview for this catchment.

1 Introduction

1.1 Integrated Catchment Management Plans

The development of this Integrated Catchment Management Plan (ICMP) has spanned 14 years and commenced in 2006, to provide guidance on how stormwater, wastewater and water supply will be managed considering future land use in the Te Awa o Kātāpaki and River North catchments as Hamilton expanded into the Rototuna Structure Plan area.

During the development of this ICMP the legislative framework has changed several times. Such changes include the recent introduction of the National Policy Statement for Freshwater Management (2020), the Hamilton City Stormwater Master Plan (2020), adoption of the Waikato Regional Council stormwater management guidelines (2019), and the development of the Regional Infrastructure Technical Specifications (2019). Best practice for stormwater management has continued to involve, as well as Council's knowledge of the catchment, performance of existing devices and localised changes in ecological characteristics.

HCC holds consents from Waikato Regional Council for stormwater discharge, water take and wastewater discharge.

- A Comprehensive Stormwater Discharge Consent (CSDC) for urban Hamilton authorises the discharge of stormwater. Under the CSDC, this ICMP is required to be developed to provide guidance for development.
- HCC's water take consent includes a stepped increase in water take for growth but requires water demand management to be implemented.
- HCC's wastewater discharge consent requires network management to avoid events such as wastewater overflows.

Refer to Section 2 for where this ICMP sits within HCC's planning hierarchy.

1.2 ICMP Scope and Area

The Te Awa O Kātāpaki catchment covers an area of approximately 770 hectares and the adjacent River North catchment covers approximately 108 hectares (refer to Figure 1). Both catchments are considered in this ICMP. The Te Awa O Kātāpaki stream has a range of reach types including artificial drains, on-line stormwater devices (Bourn Brook swale, Magellan Lake and Petersburg Drive Lake), modified stream channels, and the natural vegetated gully and stream channel downstream of Magellan Lake.

Variations between the topographical drainage catchment and the actual drainage area are present because in some places the piped stormwater network falls into the catchment against the natural topography. The ICMP catchment includes the extended network area and some secondary overland flow from the Otama-ngenge catchment.

Structure Plan land within the Hamilton City area of the catchment is zoned for urban development. It is made up of two residential areas; General Residential and Medium Density Residential, with a small community/commercial node and major transport infrastructure (Waikato Expressway) servicing the local area. A substantial amount of development has already been consented by Hamilton City Council (approximately 90% of the catchment) and up to 70% of the catchment has already been developed.

Several technical assessments have been developed to support this ICMP and stormwater guidelines, and Council has drawn on early draft ICMP outputs to inform consented development as it progressed. Meanwhile urbanisation in the catchment continues at pace. More recently, new assessments have been produced which have reviewed existing stormwater management devices, summarised the latest ecological assessments and annual catchment monitoring, and reviewed previous flood hazard models. These inputs have been used to update findings of historical assessments previously relied on during earlier drafts of the ICMP and to reflect the current legislative framework.

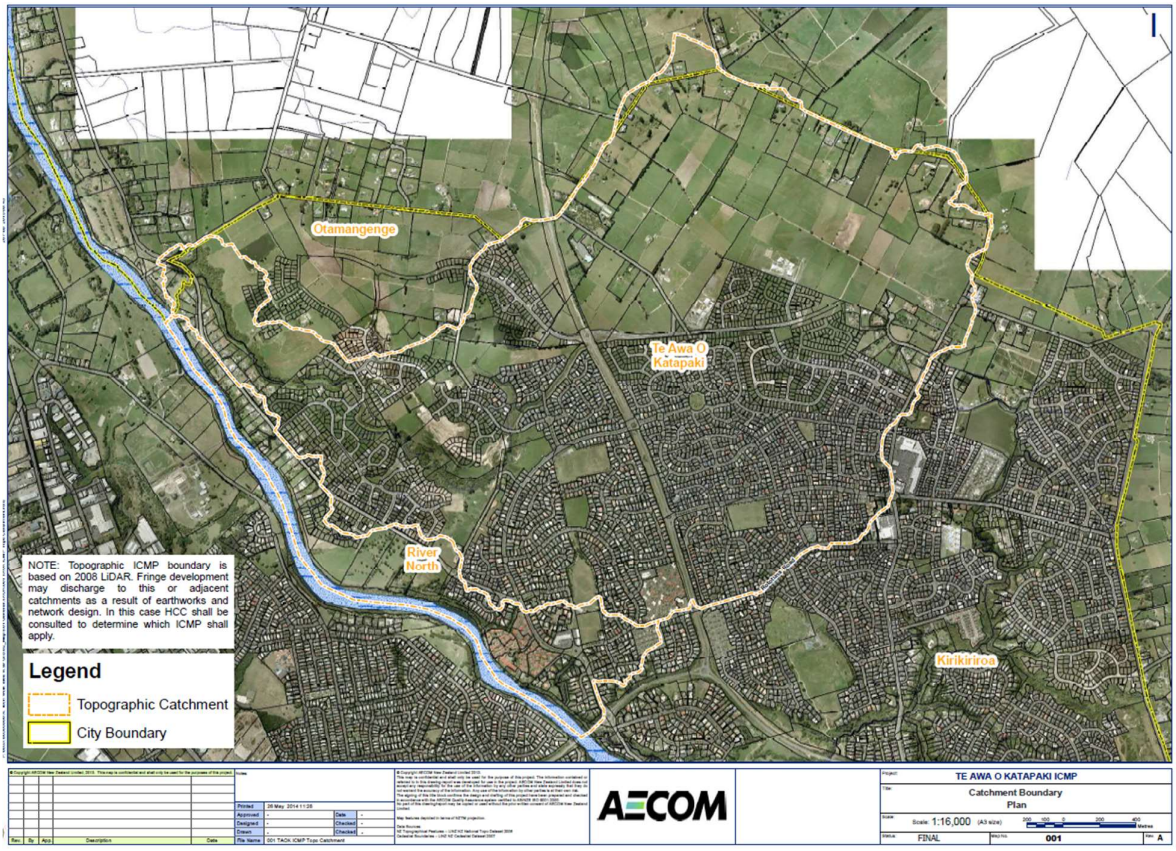


Figure 2 – Catchment Boundary Map (2014)

1.3 Rototuna Structure Plan

Part of the Rototuna Structure Plan (July 2014) is a sub-catchment of the Te Awa O Kātāpaki Catchment. The proposed Rototuna Town Centre is within the catchment. The balance of the structure plan area is in the Otama-ngenge Catchment. The Rototuna Town Centre and land to the east of the Expressway represents the final undeveloped part of the Te Awa O Kātāpaki Catchment.

This ICMP incorporates the key aspects of the Structure Plan that are relevant to catchment management. Included is the location of key infrastructure, areas to be served, and specific requirements for integration between infrastructure, development, and the natural environment. All these aspects have been developed further in this plan.

The topographical catchment area is depicted on Plan 001 in Appendix A. Small parts of the hydrological and network boundary fall within the Waikato District (<5%). There is no Waikato District structure plan for the adjacent area. The Waikato District Council process for dealing with cross boundary issues is described in the Waikato Operative District Plan Chapter 17[3].

1.4 ICMP Structure

Section 1 – Introduction
This section includes a general description of the catchment and outlines the purpose, scope and desired outcomes of the ICMP.

Section 2 – Strategic Planning Links
This section outlines the relevant legislation, statutory and non-statutory planning documents. It summarises the key rules, guiding principles and objectives from these documents followed by a compilation of the key strategic objectives for the catchment.

Section 3 – Catchment Description
This section covers existing networks, land uses, topography, hydrological, geological and ecological and cultural information.

Section 4 – Consultation
This section details the consultation program that was conducted in order to derive values of the catchment and the proposal.

Section 5 – Operational Objectives
This section outlines the objectives that cover the environmental, economic, cultural and social aspects that are to be applied to meet strategic objectives. This will consider the baseline information of the catchment including values and constraints.

Sections 6, 7, 8, 9 – Three Waters Management and Best Practical Options
These sections discuss and then establish the best management practices and mitigation measures that meet operational objectives of the ICMP, and their implementation. These sections also establish key infrastructure requirements.

Section 10 – Best Practice Requirements
This section outlines the requirements for the catchment that have been selected as a result of the information and the outcome of assessments in the preceding sections.

Section 11 – Means of compliance
This section outlines the key parameters and requirements that if achieved, will result in compliance with this ICMP.

Section 12 – Assessment of Environmental Effects
This section considers the developmental impact on people, the environment and existing infrastructure.

Section 13 – Monitoring

[3]https://www.waikatodistrict.govt.nz/Documents-Library/Files/Documents/District-Plan/Waikato-District-Plan/Chapters/Chapter17_LocalAuthorityCrossBoundaryIssues.aspx

This section specifies monitoring that will be carried out to measure the effectiveness of the mitigation measures. This includes measurable targets and performance indicators.

Section 13 – Information Gaps
This section describes information gaps that have been identified and recommendations for further study. It also lists critical assumptions that may influence the outcome of the plan and necessitate review.

1.5 Purpose of the ICMP

The purpose of this ICMP is:

i. To determine an integrated catchment management approach which is based on Best Management Practice(s) to avoid as far as practicable and otherwise minimise, the cumulative adverse effects of all new stormwater diversion and discharge activities in developing catchments.
ii. To comply with the relevant regulatory requirements including those associated with:
    1. The Hamilton City Council District Plan,
    2. The comprehensive stormwater discharge consent (CSDC) number 105279 issued by Environment Waikato (now the Waikato Regional Council),
    3. Rototuna Structure Plan,
    4. Waikato Regional Policy Statement,
    5. Vision and strategy for the Waikato River,
    6. Healthy Rivers Wai Ora.
iii. To provide guidance[4] on how water, wastewater and stormwater will be planned, constructed, operated and maintained in an integrated and cost-efficient way while allowing for future development.
iv. To ensure that the use of existing three waters infrastructure is optimised and can accommodate growth while avoiding, remedying or mitigating adverse effects that can occur from land use change. This includes effects of flooding and erosion, ad-hoc stormwater discharges and unreasonable increases in water demand and wastewater generation.
v. To ensure that existing three water networks are not compromised and future networks to accommodate growth comply with RMA requirements, HCC's Level of Service, HCC's Comprehensive Stormwater Discharge Consent and water conservation and demand management objectives.
vi. To provide a platform for requiring the implementation of water sensitive devices including the re-use of stormwater to reduce water demand and minimise infrastructure.

The vision for the Te Awa O Kātāpaki catchment, in particular the Rototuna Town Centre, is that it will become a high-quality urban environment that is based on urban design best practice, social well-being, and environmental responsibility.

The Council's goal for the Te Awa O Kātāpaki Stream is that development will seek to restore the area's natural environment. The ICMP will facilitate development in a sustainable manner, considering how the four well-beings (cultural, social, environmental, and economic) of the community in terms of water are maintained and enhanced.

[4] Guidance from this plan is generally to developers, internal HCC Units (City Waters, City Planning, Parks and Open spaces, City Development) and regulators (HCC Planning Guidance Unit, WRC, and Waikato District Council officers)

Once an ICMP is approved, all development within the catchment will be required, via the Operative District Plan (ODP), to comply with the policies, objectives and design concepts presented in the ICMP.

This ICMP has been developed to satisfy Condition 30 of the CSDC 105279 in accordance with Condition 30. Table 1-1shows where each requirement is addressed within this document.

Table 1-1 – Comprehensive Stormwater Discharge Consent Checklist

Condition 30	Status
In accordance with Condition 3(c) of this consent (CSDC), Catchment Management Plans which are prepared to guide new stormwater diversion and discharge activities in developing catchments shall be to a standard acceptable to the Waikato Regional Council and shall be submitted to the Waikato Regional Council for written approval in a technical certification capacity, prior to the establishment of these activities. Catchment Management Plans shall determine and recommend an integrated catchment management approach which is based upon the Best Practicable Option to avoid as far as practicable and otherwise minimise, the cumulative adverse effects of all new stormwater diversion and discharge activities in developing catchments.	*(General)*
As a minimum, Catchment Management Plans shall include the following information:	*(Nonspecific heading)*
a) Catchment maps/drawings of the catchment delineating the catchment boundary, catchment topography, natural features, surface water bodies, existing drainage systems and infrastructure (if any) and current land uses;	Figure 1 (Page i), Figure 4 (Page 16) and Figure 5 (Page 17). Also refer to Appendix A – Catchments; Appendix B – Topography & features; Appendix C - Infrastructure
b) Classification of the surface water bodies within the catchment as detailed in the Waikato Regional Plan;	Section 3.3 & Figure 8
c) A description of the social, economic, ecological, amenity and cultural objectives being sought for the catchment (likely to stem from a concurrent structure planning process);	Section 6.
d) A description of proposed urban growth, development and land use intensification within the catchment;	Section 3.1.
e) A list of the key stakeholders associated with the catchment, and details of their respective views on providing for new stormwater diversion and discharge activities within the catchment;	Section 5.2.
f) An assessment of the current status of the catchment and RITS environs, together with a description of the geological, hydrological, ecological and existing infrastructural characteristics of the catchment, including any existing resource use authorisations within the catchment;	Section 3.
g) An assessment of the environmental effects of all new stormwater diversion and discharge activities on the catchment, in such detail as corresponds with the scale and significance of the	The assessment of environmental effects is described for all proposed

Condition 30	Status
effects that these activities will have on the catchment, including but not limited to, effects on:	diversion and discharge activities throughout Section 13 and Appendix I and Appendix J.
i) Natural features, surface water bodies and aquifers,	
ii) Sites of cultural and/or historical significance,	
iii) Public health,	
iv) Flooding hazards,	
v) Receiving water hydrology, including base flows and peak flows in rivers and streams and long-term aquifer levels,	
vi) Receiving water sediment and water quality,	
vii) Receiving water habitat, ecology and ecosystem health,	
viii) Receiving water riparian vegetation,	
ix) The extent and quality of open stream channels,	
x) Fish passage for indigenous and trout fisheries (refer to the Waikato Regional Plan Water Management Classes for applicability),	
xi) Natural and amenity values,	
xii) Existing infrastructure,	
xiii) Existing authorised resource use activities;	
h) An assessment of the cumulative environmental effects of all new stormwater diversion and discharge activities on the catchment over time;	Section 13 and Appendix I and Appendix J.
i) In response to the environmental effects assessment information, an assessment of the available management options (including Low Impact Urban Design measures and stormwater management devices), for all new stormwater diversion and discharge activities within the catchment;	The assessment of environmental effects is described in Section 13. Management Options are described in Section 8. BPOs etc. are outlined in Sections 7 to 11.
j) Recommendations on an integrated catchment management approach which is based upon the Best Practicable Option to avoid as far as practicable and otherwise minimise actual and potential adverse effects of all new stormwater diversion and discharge activities on the catchment;	Sections 7 to 11.
k) A description of proposed education and promotion initiatives to be carried out by the Consent Holder to support the integrated catchment management approach recommended by the Catchment Management Plan;	Stormwater BMP14 and Water BMP 3 in Section 11. Section 15.1 & Table 15-2
I) A description of key infrastructure works to be carried out by the Consent Holder to support the integrated catchment management approach recommended by the Catchment Management Plan;	Section 15.1 & Table 15-2 & Table 15-2

Condition 30	Status
m) A prioritised infrastructure works schedule for implementing the integrated catchment management approach recommended by the Catchment Management Plan;	Section 15.1 & Table 15-2 &Table 15-2 Note that this prioritisation will be on a catchment scale and must be integrated into the citywide programme of works.
n) A list of performance measures by which the implementation of the integrated catchment management approach recommended by the Catchment Management Plan will be gauged.	Provided in Section 14
Any approved Catchment Management Plan that needs to be updated following changes to the integrated catchment management approach recommended by the Catchment Management Plan, shall be reviewed, updated and submitted to the Waikato Regional Council for approval in a technical certification capacity, prior to any such changes being implemented within the associated catchment.	Provided in Section 1.6
Advice Note: It is recognised that Catchment Management Plans may also include information that provides for the integration of municipal water and wastewater services. Such information and the integration of these services are generally encouraged by the Waikato Regional Council, particularly where they result in environmentally sustainable catchment management outcomes.	Three Waters Management is considered throughout the ICMP.

1.6 Duration of ICMP

The duration of this ICMP is the "planning horizon" of the Rototuna Structure Plan but will necessarily extend beyond the full development of the Structure Plan area to allow for on-going decision making on management and maintenance of water, wastewater and stormwater infrastructure, and to allow for connectivity to adjoining land and catchments.

This ICMP is to be reviewed periodically to ensure that it remains relevant and considers the results of any ongoing monitoring and changes within the catchment – refer to Section 17.

1.7 Level of Service and Performance Criteria

Levels of Service are documented in different levels of detail in various key documents. In some sub-catchments, higher levels of service for flood management will be required.

Key Levels of Service include:

- Wastewater – no additional wet weather overflows due to development (volume and frequency)
- Water pressure – minimum 10m head at the property boundary
- Stormwater – management of 2-year, 5-year and 10-year storm events (in accordance with land use type)

Refer to the following documents for further level of service and key design standards information:

a) Operative Hamilton District Plan
b) Regional Infrastructure Technical Specifications
c) Hamilton City Council Stormwater Modelling methodology
d) Hamilton City Council Standard Assessment Methodology – Water (Model)
e) Hamilton City Council Standard Assessment Methodology – Wastewater (Model)
f) Hamilton City Council 2018-28 10 Year Plan
g) Waikato Regional Council's Long-Term Plan 2018 – 2028
h) Hamilton City Council Bylaws (including Water, Trade Waste & Wastewater, and Stormwater)
i) Hamilton City Council Water Master Plan June 2016
j) Hamilton City Council Wastewater Master Plan June 2016
Hamilton City Council Stormwater Master Plan June 2016
k) Waikato Regional Council Technical Report 2014/13 –Managing land use change and Council's administered drainage areas
l) Waikato Regional Council's Waikato Stormwater Management Guideline
m) Waikato Regional Council's Waikato Stormwater Runoff Modelling Guideline

Requirements of the District Plan for addressing matters in a water impact assessment must also be met.

2 Strategic Planning Links

Development within the Te Awa O Kātāpaki Catchment and River North catchment must be consistent with statutory central and regional government policies, plans and resource consents, and HCC policies and plans.

Non-statutory policy and planning documents that may influence catchment management and development must also be taken into account.

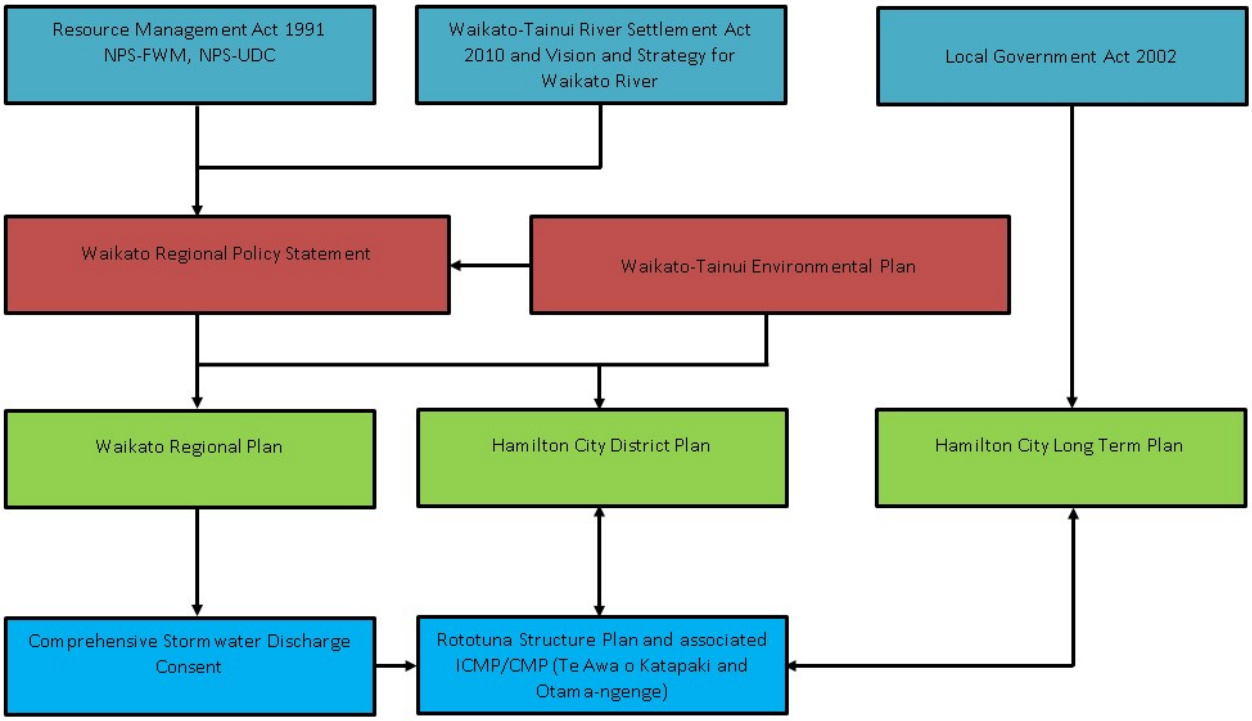


Figure 3 - Statutory Planning Framework

2.1 Statutory policy and planning documents

The following documents are currently seen as being relevant for development within this ICMP area.

a) Resource Management Act (1991), including the 2021 RMA Amendment Bill for Medium Density Residential Housing
b) Local Government Act (2002)
c) National Policy Statement for Freshwater Management (2014)
d) Waikato Tainui Raupatu (Waikato River) Claims Settlement Act (2010)
e) Waikato Tainui Environmental Plan
f) GEC Vision and Strategy
g) Waikato Regional Policy Statement
h) Waikato Regional Plan

i) HCC comprehensive stormwater discharge consent 105279
j) Hamilton City Operative District Plan
k) Hamilton City Long Term Plan
l) Rototuna Structure Plan

2.2 Non-statutory planning documents

a) Future Proof and Sub Regional 3 Waters Strategy
b) Regional Infrastructure Technical Specifications (RITS)
c) Hamilton City Council Stormwater Management Plan
d) Hamilton City Council Master Plans (Water, Wastewater and Stormwater)
e) Hamilton City Council Environmental Sustainability Strategy
f) Hamilton City Council Gully Reserves Management Plan
g) Hamilton City Council Reserves Management Plan
h) Hamilton City Council Urban Growth Strategy (2010)
i) Waikato River Catchment Services –Levels of Service and Funding Policy
j) Sustainable Subdivision Development – An Environmental Waikato Perspective
k) Flood Hazard Maps (where available)
l) Waikato River Independent Scoping Study
m) Preparing for Future Flooding – A Guide for Local Government NZ
n) Water Safety Plan
o) Waikato Regional Council's Waikato Stormwater Management Guideline
p) Waikato Regional Council's Waikato Stormwater Runoff Modelling Guideline

2.3 Resource Consents and Designations

Development planning and implementation shall be carried out to comply with all HCC held resource consents, HCC Bylaws, levels of service, designations, and easements. Resource consent requirements in relation to development will normally be communicated when a development application is assessed (i.e. trade waste requirements for wastewater, high water users).

Developers and designers should seek advice from HCC and Land Information New Zealand (LINZ) as to the presence of designations or easements, prior to the initial planning phase. The same should apply to other major service providers (i.e. power or gas).

2.4 Strategic Issues

The key issues coming from the strategic planning documents listed above that need to be addressed in three waters management and urban development in general are as follows:

a) Erosion and instability of waterways
b) Water quality and mauri of waterways
c) Flood risk and natural flow regimes
d) Quality of riparian areas

e) Water supply to meet demand and levels of service
f) Water conservation stormwater re-use
g) Stream and riparian habitat
h) Ad-hoc planning and development
i) Indigenous biodiversity

High level strategic objectives have been distilled from those documents and are provided below.

2.5 Strategic Objectives

Development within the Te Awa O Kātāpaki and River North catchment is influenced by central and regional government policies, plans and resource consents, Hamilton City Council policies and plans and to a degree, Waikato District Council policies and plans. Most policy and rules ultimately flow out of the Regional Policy Statement (RPS) which is given effect through planning documents such as District Plans and Regional Plans. The RPS also reflects iwi aspirations for the region and National Policy Statements.

Relevant chapters in the Hamilton City Council District Plan that reflect direction coming from the RPS include Chapter 20 Natural Environments, Chapter 21 Waikato River Corridor and Gully Systems, Chapter 22 Natural Hazards, Chapter 23 Subdivision, Chapter 25.2 Earthworks and Vegetation Removal, Chapter 25.13 Three Waters, Chapter 2 Strategic Framework (see 2.2.7, 2.2.8 and 2.2.9), and Chapter 3 Structure Plans (see 3.3.3 and 3.3.6).

The guidance document 'Integrated Catchment Planning - Planning Guidance and Principles', provides detail on policies to be taken account of when changing land use, and can be requested from Hamilton City Council[5]. Common strategic objectives have been set across all catchments within the Hamilton City Council jurisdiction (refer Table 2-1 below).

Table 2-1 – Strategic Objectives

Ref No.	Strategic Objectives
SO1	Protect freshwater systems Maintain, protect and enhance freshwater ecosystems and natural drainage systems by safeguarding the life-supporting capacity, improving water quality where degraded and protecting significant values of wetlands and outstanding freshwater bodies.
SO2	Protect terrestrial systems Maintain, protect and enhance indigenous biodiversity values and functions for terrestrial ecosystems and protect significant habitat of indigenous fauna.
SO3	Kaitiakitanga Give effect to the relationship of tangata whenua as kaitiaki of receiving water bodies and including the relationship of Waikato-Tainui with the Waikato River.
SO4	Stormwater Management Stormwater management related to land use and development shall encourage and enable low impact design, reduce impermeable surfaces where possible, utilise at-source treatment (including, but not

[5] TRIM D-928128

Ref No.	Strategic Objectives
	limited to, on-lot treatment devices) to reduce reliance on downstream devices, and incorporate best practicable mitigation measures to minimise actual and potential adverse effects on: • Receiving water bodies in terms of quantity and quality of stormwater discharges, • Locations and communities subject to flood hazards, • Natural groundwater levels, • Baseflows for freshwater systems.
SO5	Wastewater Management Wastewater management shall incorporate best practicable options and be managed so that: • Conveyed network volumes are minimised, (e.g. by demand management and management of stormwater infiltration) • Dry weather overflows are prevented, and wet weather overflows are minimised.
SO6	Potable Water Management Water supply is planned and provided for in a way that meets existing and future requirements to: • Provide firefighting water supply (flow and pressure) by conforming to the Code of Practice for Fire Fighting Water Supplies. • Meet domestic, commercial and industrial water demand. • Ensure water consumption is managed to minimise peak and total demand.
SO7	Three Waters Management Three waters networks are planned, managed and operated in an integrated manner to: • Meet existing and future development requirements whilst maintaining human and ecosystem health. • Meet design standards, consent conditions and regulatory levels of service. • Ensure assets, technology and resources have capacity, redundancy (n+1), knowledge and plans to prevent or cope with unplanned events. • Minimise the need for new infrastructure including by optimising the use of existing assets.

3 Catchment Descriptions

In accordance with Condition 30 of the CSDC, Section 3 of this ICMP provides a broad range of data and maps to describe the physical, cultural, environmental, infrastructure, economic and future development characteristics of the hydrological Te Awa O Kātāpaki catchment and the adjacent River North catchment. This Section is supported by maps contained in the Appendices.

The Catchment area covers about 872 hectares of what was rural land located to the northeast of Hamilton City. The catchment has four main drainage areas as shown on Plan 002 in Appendix A.

The catchment to the Te Awa O Kātāpaki Stream is about 764 hectares and the balance discharges direct to the Waikato River from the River North Catchment. Adjacent to the Te Awa O Kātāpaki Catchment northern boundary is the Otama-ngenge catchment. The Kirikiriroa Stream catchment is adjacent to the southern boundary.

The total length of drainage infrastructure in the catchment is about 60 km, 12 % of which is open watercourse, 82 % is piped network and 1 % is farm drain (as at 2016). There are no lined channels in the catchment apart from a short section of channel between the Borman Road pipeline outlet and the Resolution Drive box culvert.

The wastewater and water networks are fully integrated into the city networks. Development has created a stormwater network which discharges part of the Otama-ngenge topographical catchment into the Te Awa O Kātāpaki Stream. The network catchments and overlapping areas with the adjacent Otama-ngenge Catchment are shown on Figure 4 and Plan 002 in Appendix A.

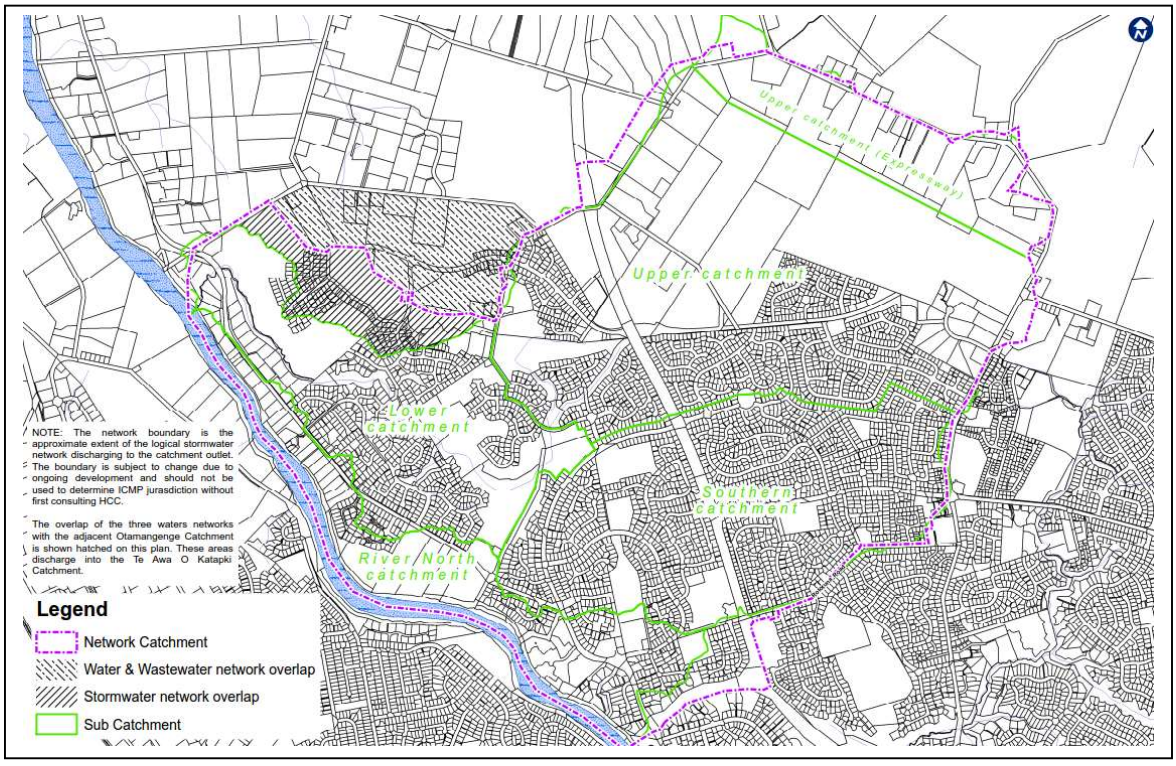


Figure 4 – Sub-catchment plan

Figure 5 shows the areas of the adjacent Otama-ngenge Catchment that have a stormwater network discharging to Te Awa O Kātāpaki catchment.

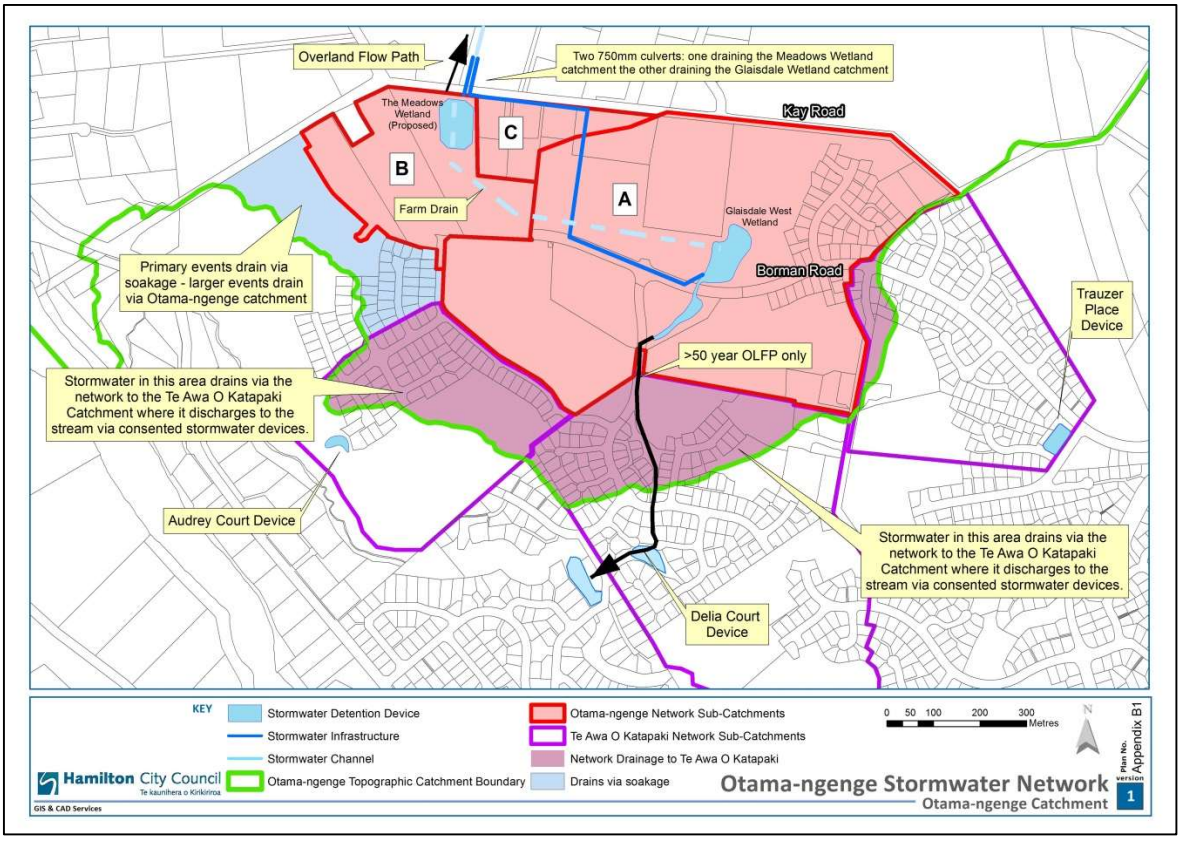


Figure 5 – Portion of Otama-ngenge discharging to Te Awa O Kātāpaki Stream

Stormwater from this catchment is discharged to three Te Awa O Kātāpaki stormwater devices, these being Delia Court, Audrey Place and Trauzer Place. Each device can serve these catchment areas. Refer to Appendix F for details.

The Otama-ngenge catchment has a secondary overland flow path from the Glaisdale wetland (Otama-ngenge sub-catchment A) to the Te Awa O Kātāpaki stream. The overland flow path will activate if flows exceed the capacity of the primary wetland outlet pipe (or if the primary outlet becomes blocked) and the wetland is full. The secondary overland flow path discharges through the Eton Estate development to the south and onto the Te Awa O Kātāpaki catchment. Two affected private properties have easements on their titles for this purpose.

3.1 Land use

3.1.1 Historic and cultural land use

As part of background investigations to the Rototuna Structure Plan, a report[6] for Rototuna Stage 4 was prepared by Nga Mana Toopu O Kirikiriroa that researched the historical use of the wider Rototuna area. The area served as:

- Hunting grounds for trapping native birds

[6] Nga Mana Toopu O Kirikiriroa, Tangata Whenua Historical and Cultural Assessment, Rototuna Stages 3 and 4

- Cultivation areas
- Creeks for gathering tuna (Eels)
- Fresh water mussel beds
- Inanga (white bait) collection points
- Kokowai (ochre) deposits highly prized for adornment for carvings
- Taonga (treasure)

Many of the domestic and ceremonial features that were part of the construction and life of Pā or Papakāinga were made of wood – anything buried in the ground may still be there (above ground would have perished). There are many borrow pits (middens) in the area, indicating that in pre-European times there was a significant Maori population living and cultivating crops. Hence it is likely that there are structures and artefacts still buried in the soils of the area.

3.1.2 2016 Land Use

About 75% of the catchment was urbanised in 2016. Urban areas were a mix of low to medium and large lot residential and one commercial zone. There were existing schools, a church, and sport and recreation areas. Undeveloped areas were grazed farmland.

As part of the CSDC, urban growth is monitored. The table below shows how the Rototuna Structure Plan area (of which Te Awa O Kātāpaki falls in) has been progressively developing[7].

Table 3-1 – Developed and developing areas

Suburb	Development type	Urban development (hectares)				
		2012/13 Baseline	2013/14	2014/15	2015/16	2021/2022
Rototuna	Developing	36.0	40.4	78.8	112.6	128.2
	Developed	80.5	107.0	127.7	138.2	319.9
	Undeveloped	390.5	359.6	300.5	256.2	58.9
	Total area	507.0				
Total TAOK Catchment Area		764.0				
Undeveloped % (of total catchment)		**51**	**47**	**39**	**33**	**16**

Based on the table above it is apparent the undeveloped area in the catchment is sitting at 16% in 2021/2022.

3.1.3 Proposed Land-Use Changes and Planning Provisions

Most of the Rototuna Structure Plan land is zoned for residential purposes, made up General Residential (traditional lower density development) and Medium Density Residential (more compact residential form[8]). The Rototuna Town Centre is provided for in the District Plan. Drainage to service the Town Centre area was underway at the time of writing this ICMP.

The residential area can be expected to have residential imperviousness surfaces of around 60 – 70 % once it has been fully developed. Appendix A shows the Rototuna Structure Plan for the area.

[7] Comprehensive Stormwater discharge consent 105279, 2015/16 Monitoring Report, Tonkin & Taylor, September 2017
[8] Requirements of Future Proof and to give effect to the Waikato Regional Policy Statement.

Much of the undeveloped land in the lower catchment is consented. In the upper catchment there are some areas of unconsented land that are likely to be developed in 2021-2024. The upper catchment includes the four lane Waikato Expressway currently under construction.

There is little opportunity to change master planning aspects because significant development has already been undertaken. Networks will be operated as currently planned. Planning for this area was carried out in the last 10 years so is reasonably aligned with recent standards and growth predictions.

Residential development of rural areas is likely to result in a long-term reduction of nutrient and faecal pathogen inputs into surface water with the change from the existing predominant agricultural land use. However, it will likely result in an increase in inputs of urban contaminants, including litter, suspended solids, heavy metals, PAHs, and phosphorus, and the increase in impervious surfaces also leads to an altered hydrological regime and the associated effects in receiving surfaces waters.

Further information can be found on the Rototuna structure Plan in: https://www.hamilton.govt.nz/our-council/council-publications/districtplans/ODP/chapter3/Pages/3-5-Rototuna.aspx

Differences may arise between modelled growth and consented/expected growth. It is likely that differences will not be significant or will be within normal planning and design tolerances and expectations. In this regard the model results are appropriate for this catchment and only significant deviations from land use and zoning might require further assessment.

3.1.4 Major transport links

The Rototuna Structure Plan shows the location of existing and planned arterial roads. Refer to Appendix A and Figure 7[9].

The Hamilton Section of the Waikato Expressway cuts through the north eastern area of the Rototuna growth cell. It is expected that Kay Road and Horsham Downs Road will continue to provide access to properties to the north east of the Expressway. The Hamilton Section of the Waikato Expressway is expected to be completed in 2022. Resolution Drive is planned to connect to the Expressway and be constructed at the same time. The Expressway shall carry out its own treatment and attenuation in accordance with its own resource consent requirements. The Expressway has not been allowed for in any of the HCC devices including the Bourn Brook swale.

The RPS, Regional Land Transport Plan, Hamilton City District Plan and Access Hamilton Strategy also recognise a future arterial link from the central interchange on the Te Rapa Bypass to Resolution Drive, including a northern river crossing bridge. The alignment of the arterial link and its connections to other networks will be determined through a Notice of Requirement process. Any construction staging will be timed and planned to align with growth.

The roading network will be designed so that it supports public transport services, cycle and pedestrian facilities. In addition to this, off-road cycle and pedestrian facilities will be integral to the development of the area. A network of off-road facilities as indicated on the Rototuna Structure Plan.

The new roading network and associated increase in traffic will result in increased heavy metal contaminants, hydrocarbons and direct discharges of sediment. Treatment for stormwater runoff for all

9 Also refer to District Plan, Vol 2, Appendix 15, Figure 15-5b, Appendix 2, figure 2-4 and 2-5.

roads needs to be appropriate for anticipated traffic loads and associated contaminant loads. These combined impacts will be managed predominantly by constructed wetlands discussed later in this ICMP.

Figure 6 shows the extent of the Hamilton Section of the Waikato Expressway.

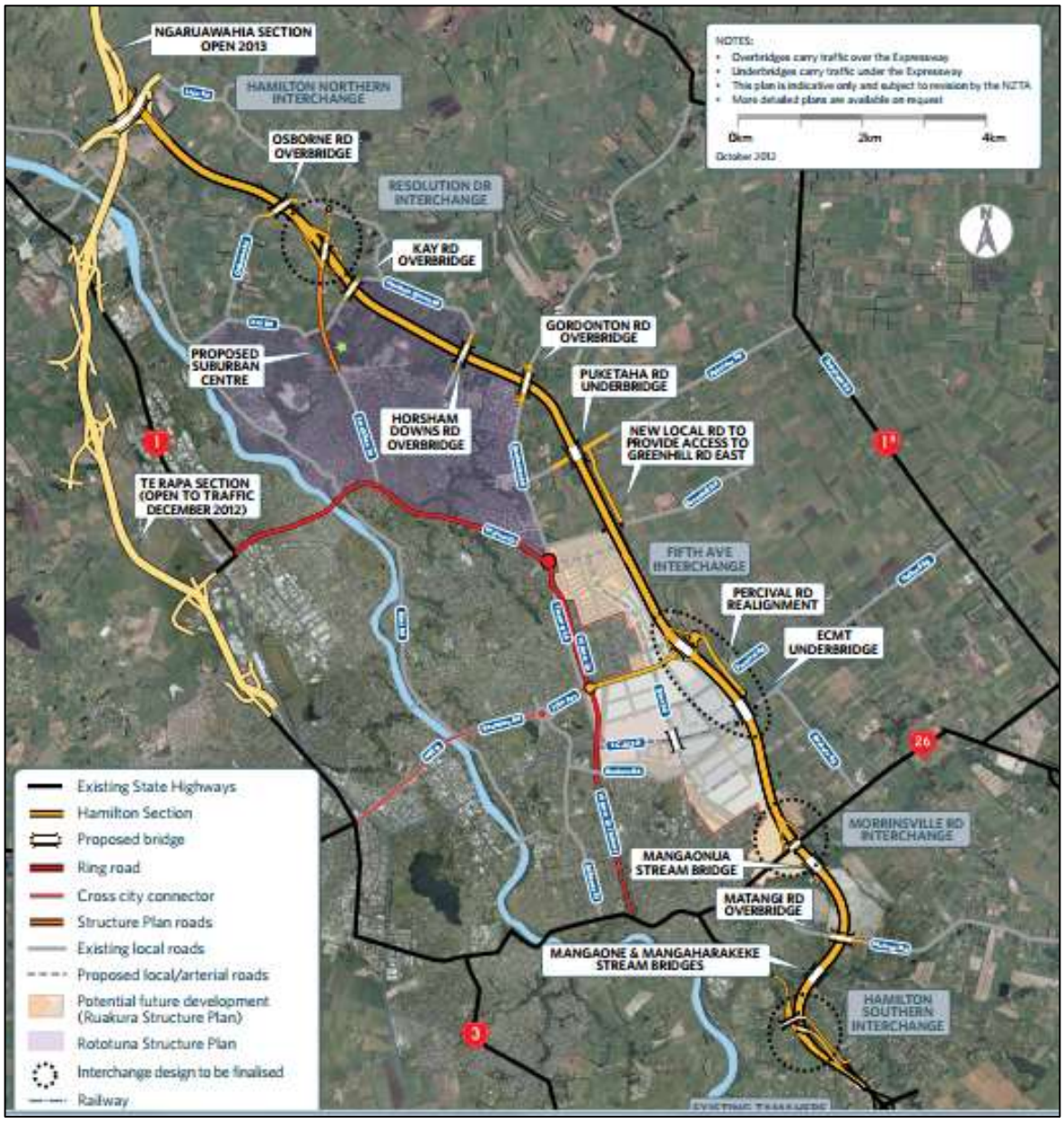


Figure 6 – Key major transportation features

Figure 7 shows the transport network in the Rototuna Structure Plan.

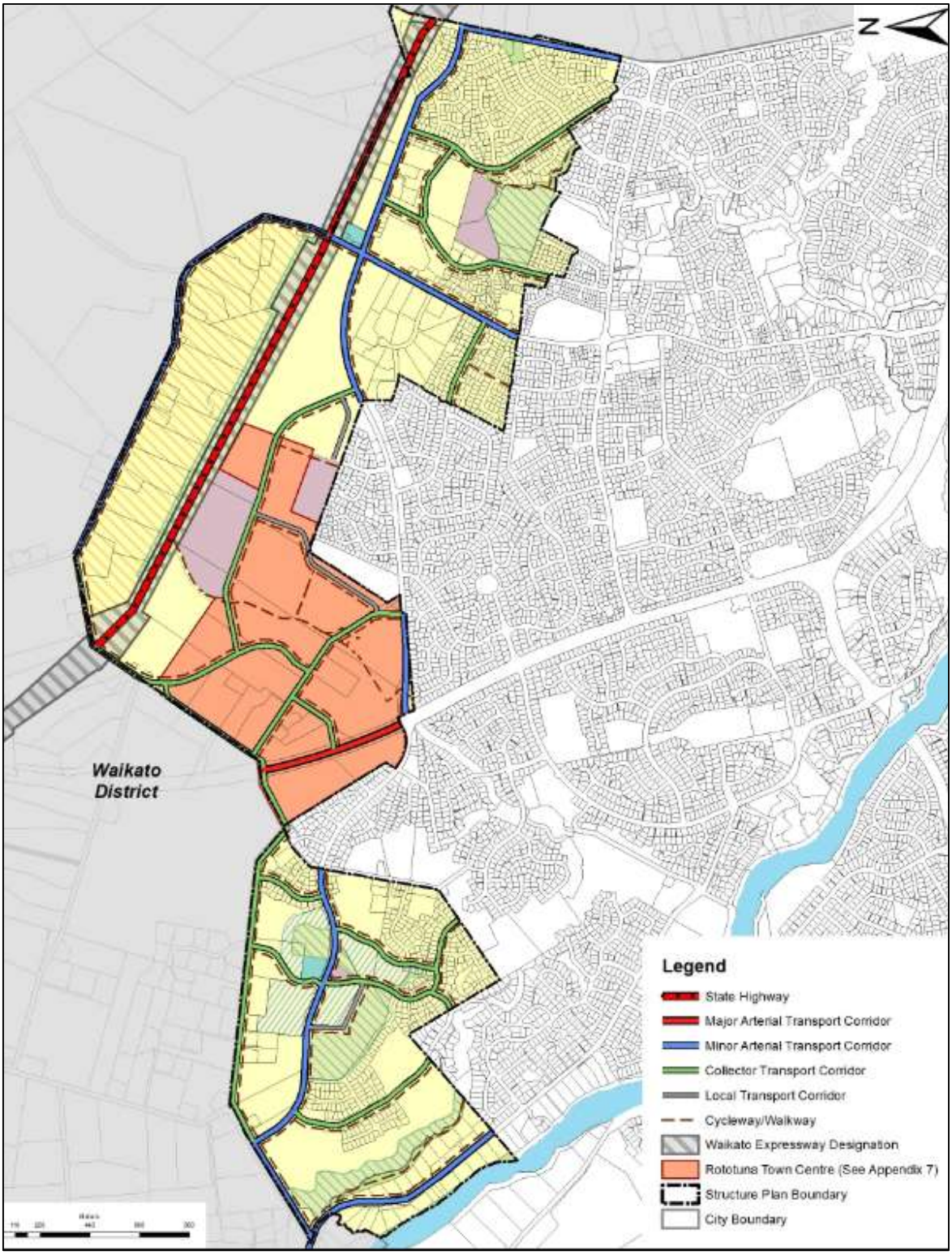


Figure 7 – Proposed Structure Plan Transport Corridors

3.2 Surface water features and sub-catchments

See Figure 4 for sub-catchment boundaries and Section 3.8 for further detail on floodways and lakes. The catchment is made up of the following waterway classifications (refer to Figure 8 in Section 3.3):

- Artificial farm drains, modified watercourse and swales in the upper catchment
- Natural stream in the lower catchment
- Modified streams in the lower catchment
- Two artificial lakes in the lower catchment
- Stormwater treatment devices

3.2.1 Te Awa O Kātāpaki - Upper Catchment

The Upper Catchment (411 hectares) features flat area that is surrounded by moderately sloping rolling hills. The upper catchment is comprised of:

- Artificial farm drains, some of which are being converted to swales.
- Modified watercourse
- Constructed stormwater swales.
- The Tuirangi floodway – An artificial channel created to replace the original Te Awa O Kātāpaki Stream to facilitate land development (located between Resolution Drive and Magellan Lake).
- The Trinidad Place tributary - draining the area from north of Cumberland Drive to Magellan Lake.

The Expressway Catchment is a sub-catchment of the Upper Catchment which is bounded by the proposed Waikato Expressway designation. At the time of writing the upper catchment is mostly grazed pasture. Planning and design for development is underway. The upper catchment has a slow rainfall response in its pre-developed state.

Constructed farm drains convey water to a remnant natural watercourse on the eastern side of Resolution Drive which is currently being developed as the Rototuna Town Centre and swale. Ponding occurs on the flat areas of pasture. Ponded water eventually soaks into the ground.

The Tuirangi Floodway serves the upper catchment and incorporates the Bourn Brook swale. The floodway replaces farm drainage, so is a habitat and aesthetic improvement not classed as being online. This system will drain the upper west development catchments to the mainstream via culverts under Borman Road.

3.2.2 Te Awa O Kātāpaki- Lower Catchment

The Lower Catchment (143 hectares) consists of a mixture of flat and gently sloping land close to the Te Awa O Kātāpaki Stream. The stream in this area is in an incised flood plain and discharges to the Waikato River near Kay Road. Development is underway within this area and is nearing completion. Key features in the lower catchment include the following:

- Mainstream
- Lake Magellan (major)
- St Petersburg Lake (minor)

The mainstream is entrenched about 10 m below the level of flat areas in the vicinity of Sylvester Road, increasing to 15 m at River Road. Tributaries are typically short gully arms or extensive farm drains. In developed areas, surface drains have been replaced with pipes. The natural stream in the lower catchment (downstream of Magellan Lake) provides the catchment's main section of environmentally valuable habitat. This section of the stream is about 2.5 kilometres in length. Riparian vegetation is extensive in parts.

Sub-catchment topography is such that this area is expected to have a medium response to rainfall in its pre-developed state when compared to the upper catchment. Ongoing development will be increasing the runoff from this sub-catchment. Flow attenuation is being incorporated to minimise the impact on the stream.

Gully slopes are well vegetated with grass or regenerating native and weedy shrub growth. The valley floors are typically wide and flat. The gully slope profile typically comprises steep (30° to 45°) upper sections above moderate to gentle slopes. The lower slope merges with the flat and typically swampy gully floor. Slight raised banks of flood deposited sediment form locally beside the stream course. The main watercourse is 1 m to 3 m wide and up to 3 m deep.

Magellan Lake is a manmade feature formed within the original stream for the purpose of stormwater treatment and control. While the lake is complying with resource consent conditions, downstream effects are likely. See Section 11.5 for further discussion. Another smaller lake (St Petersburg Lake) is located downstream of Magellan Lake.

The Te Awa O Kātāpaki Stream and its tributary drains do not have a regional water class rating. The stream is one of Hamilton's more ecologically intact gully systems from the Waikato River up to Magellan Lake. There is potential to improve and restore habitat quality by creating buffer and re-planting riparian margins as well as ensuring stream flows are adequately treated and maintained. Soakage and extended detention will help to maintain groundwater seepages and stream base flow.

3.2.3 Te Awa O Kātāpaki - Southern Catchment

The southern catchment (210 hectares) is a fully developed urban area. This area is drained by a conventional piped collection system discharging to multiple locations on the Te Awa O Kātāpaki Stream.

This area has a relatively fast response to rainfall when compared to the upper catchment because it has been fully developed and all runoff is piped directly to the stream. No elements of the former stream gully system remain in this part of the catchment.

3.2.4 River North Catchment

The River North Catchment (108 hectares) consists of a mixture of flat and gently sloping land bordering the Waikato River. Close to the river, the land drops steeply to river level. Development is underway within this area and is nearing completion; the southern and central areas of the catchment are consented as at 2017.

The sub-catchment has three small first order waterways with a mixture of exotic and native shrub and tree riparian cover.

- The northern most waterway is a gully that runs from a culvert under River Road in a south westerly direction through Featherstone Park. This waterway has a pond in the upper section 10m from a River Road culvert which was most likely formed post 2009.
- The middle waterway has a single online device.
- The southern waterway is in the base of a relatively unmodified gully with headwater wetlands. In 2016, at least the upper third of the channel is likely ephemeral with shallow groundwater flows from upstream wetlands emerging as the gully deepens.

Location and topography are such that the River North Catchment area can discharge stormwater direct to the Waikato River with no effect on local flooding. Ongoing development will increase runoff volumes, but flow attenuation is not proposed because of its proximity to the Waikato River and lack of impact on flooding.

A 20-hectare subdivision in the Te Awa O Kātāpaki Stream (lower) catchment drains to the northern waterway of the River North catchment without treatment. The northern waterway is noted as a significant habitat by Boffa Miskell. A treatment device will be needed for enhancement when downstream development is carried out. This may be able to be achieved by upgrading an existing pond; a separate project to understand feasibility and design details will be required.

3.2.5 The Waikato River

The Waikato River is a significant water body running through the city. The river services a large catchment and is highly modified due to many influences in addition to urbanisation (i.e. upstream farming activities, hydro dams). The river is highly valued, and a key objective of many policy and planning documents is to improve the health of the river.

For the purpose of this ICMP, sub-catchments discharging direct to the Waikato River (River North) will be required to achieve a minimum of RITS (or other equivalent document) discharge quality standards. Extended detention and attenuation for quantity management will have little or no effect of the river, therefore will not be a requirement for 'direct' discharges from the River North sub-catchment.

3.3 Waterway Classification

Key Update	Key Mitigation	Conclusion
1. **Watercourse and wetland classification mapping has been completed in the upper catchment. Eight areas have been classified as possible natural wetlands.**	Further assessment of the 'possible natural wetlands' in the upper catchment will enable effects of development to be assessed against the National Environmental Standards for Freshwater Regulations 2020.	Means of compliance table clearly requires the identification the protection of historic and remnant natural wetland areas in the catchment.

The Te Awa O Kātāpaki and River North catchments comprise of artificial, modified, and natural stream areas. In December 2021 **watercourses** were walked to ground-truth the extent and classification of each and mapped during the walkover. There were numerous artificial watercourses in the North Rototuna area, some being reasonably deep channels that would support standing and flowing water most of the year, and other shallow watercourses that would have water intermittently. These were distinguished by using the terms 'farm drains' for the deeper watercourses and 'swales' for the shallower ones. For clarity, both are artificial watercourses under the definition in the WRP (Table 1.2).

3.3.1 Wetland identification and classification

Most of the North Rototuna area inspected was observed to have dark soils with visible organic matter, this included the soils observed at all the possible natural wetlands visited. Manaaki Whenua / Landcare Research describe the majority of the TAOK ICMP catchment, especially the North Rototuna area as imperfectly to poorly drained and classified as having orthic gley and orthic podzol soils. Orthic gley soils are chemically reduced soils that are strongly affected by waterlogging (chemical reduction is caused by high water tables that limit oxygen). Orthic podzols occur in areas of high rainfall and are usually associated with forest trees with an acid litter (possibly in this case, historic kahikatea stands) and are associated with slow permeability. These soils are typical of where wetlands have been located historically.

Land use within the areas that were visited was mainly farmland with pasture grassland and/or currently being planted for maize cropping. Some areas were also being developed with earthworks in progress at the time of the site visit.

There were eight areas (W1-8) that have been classified as natural wetlands in North Rototuna area. Classification, description, and approximate area are provided in Appendix J. All areas have been categorised as possible natural wetlands due to not having been delineated using the WDP.

Any development that may impact on possible natural wetlands W1 to W8 will require a further WDP assessment to confirm status under the NPS-FM, and potentially an ecological assessment to inform an assessment of effects under the NES-F. There is a possible wetland in the north of the catchment (W8) that has been identified as part of resource consent process for the development of that area. This area was not ground-truthed during the sit visit and we have not seen any WDP results for any delineation carried out.

Figure 8 shows the extent and classification of these watercourses and wetlands as of December 2021. The stream does not have a cultural classification.

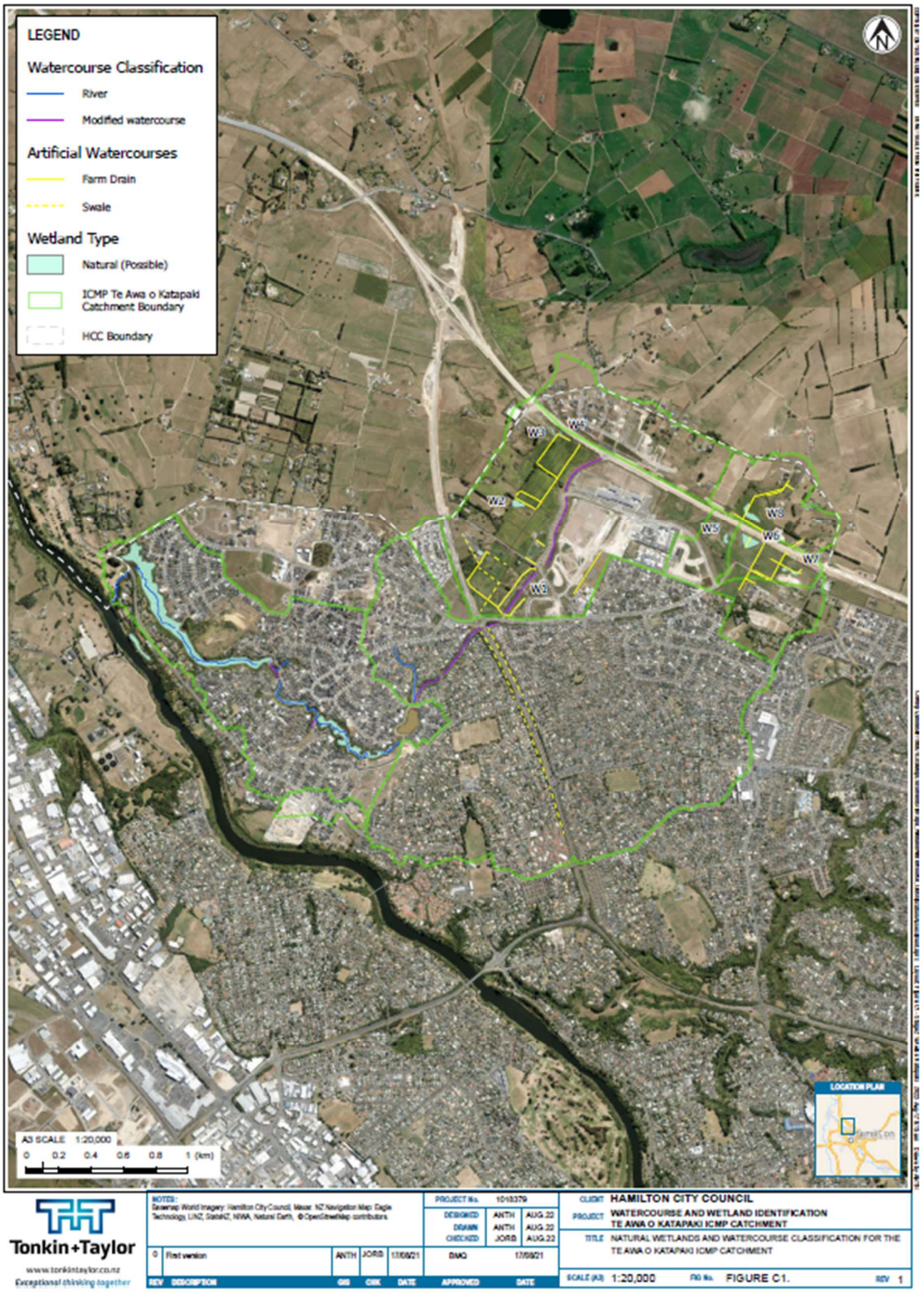


Figure 8 – Te Awa O Kātāpaki Waterway classification

Freshwater Solutions (consultancy)[10] has classified the River North northern tributary as ephemeral. See Appendix J for a larger diagram.

3.4 Physical Environment

3.4.1 Topography

The Te Awa O Kātāpaki catchment is defined by flat or gently undulating areas surrounded by moderately sloping, irregular shaped hills up to 30m higher than the flat areas. Hilly features typically range from 31 m to 51 m above sea level while the flat area typically ranges from 31 m to 35 m above sea level.

A natural gully system forms the Te Awa O Kātāpaki Stream at the south-western corner of the catchment. The stream drains west into the Waikato River. The surrounding hills are furrowed by moderate to steeply incised gullies that provide a drainage path to low lying areas and the main gully system.

The main gully system is divided into two parts by a low ridge upon which Sylvester Road is located. East of the ridge the tributary channels are shallow. West of the ridge the stream is deeply incised into the plain. The lower reaches are bordered to the south and east by low, rolling ridges.

The River North Catchment slopes gently from River Road in a north-south direction.

Refer to Appendix B for a contour map (Plan 008).

3.4.2 Geology and Geotechnical Hazards

The geology of the catchment can affect development and the environment. Land stability and erosion potential affects the location of buildings and the potential effects on the stream environment.

Tonkin & Taylor undertook an assessment of the geology of the catchment in March 2004. The findings of this assessment are summarised in a report '*Te Awa O Kātāpaki Catchment, Assessment of Geology, Hydrology and Gully Stability*'. Excerpts from the report are included below.

The catchment is in the Hamilton Basin, which is part of the mid to lower reaches of the Waikato River Valley. In the Basin the river valley is filled with thick and mainly alluvial sediments, interspersed with distal p yearoclastic deposits and air fall tephra (volcanic ash) originating from the Taupo Volcanic Zone.

The later stages of sediment deposition (Karapiro and Puketoka Formations) created a broad surface that, in the mid Pleistocene, was eroded and dissected forming the low, rolling ridges and hills that characterise the Basin. The hills were covered with volcanic ash prior to deposition of the Hinuera Formation volcanoclastic alluvial sediment 15,000 to 26,000 years ago. The silt to gravel sized Hinuera sediment formed the present low relief plains between the hills.

The Waikato River and its tributaries were deeply incised into the erodible Hinuera Formation sediments soon after deposition ceased resulting in the present system of steep-sided, flat-bottomed gullies.

The underlying geology of the catchment area comprises elevated rides of moderately consolidated sediments that form part of the Puketoka or Karapiro Formation (Walton sub-group) and lower lying plains comprising Hinuera Formation sediments.

[10] August 2016

Figures in Appendix D show the geological map for the catchment and illustrate the typical geohydrological regime.

3.4.3 Hydrogeology and groundwater resources

Hydrogeology and groundwater affect stream base flow and seepages which in turn form an important part of the stream environment. Urban development in Hamilton does not involve the taking of groundwater but does reduce natural infiltration due to increased impermeable surfaces. Increased runoff due to development can affect stream condition due to both increased flows and a reduction in the long-term base flow.

Ground investigations were undertaken by Tonkin & Taylor (March 2004) to establish groundwater conditions in the catchment. The investigations involved the installation of thirty-five boreholes. Groundwater was encountered in all thirty-five boreholes drilled within the catchment area. The investigations found some areas have a high-water table.

Groundwater levels ranged from 24.0 m – 33.0 m RL (0.6 m – 7.0 m below ground level) within the low-lying Hinuera surface and between 35.0 m – 45.0 m RL (0.9 m – 5.0 m below ground level) within the higher elevation Puketoka Formation.

Tonkin & Taylor modelled the groundwater results to establish a site wide groundwater profile and flow direction. Interpolated groundwater contours across the site are presented in Appendix D.

Groundwater behavioural features highlighted include the following:

- A general southwesterly groundwater flow within the flat lying central area at a hydraulic gradient of 1:500.
- A steepening of the hydraulic gradient towards the head and sides of the main stem of the Te Awa O Kātāpaki gully towards the Waikato River.
- A steep hydraulic gradient of between 1:5 and 1:10 within the topographical highs. The gradient then flattens out towards the base of the slope.
- Groundwater springs typically occur at the head of incised drainage gullies and towards the toe of the slope along the main stem of the Te Awa O Kātāpaki gully.
- Localised perched aquifers can exist within the finer grained slope wash sediments at the base of the elevated ridges.

The high-water table in some areas does not preclude the use of soakage as a primary management option. Developers will need to undertake enough testing to determine if suitable soakage characteristics are present. Guidelines on requirements for soakage testing and design are provided in the RITS. Geological reports can be requested from Hamilton City Council[11].

There are several consented groundwater takes mapped on Waikato Regional Council website in the Waikato District Council area of the catchment. Refer to Plan 010 in Appendix C for locations of the takes.

[11] TRIM D–719026

Water takes within undeveloped areas are likely to be abandoned when development occurs, and the city water network is extended.

Subsurface Soil Profiles

Four typical profiles exist within the Te Awa O Kātāpaki stream system as shown in Figure 9 and described below.

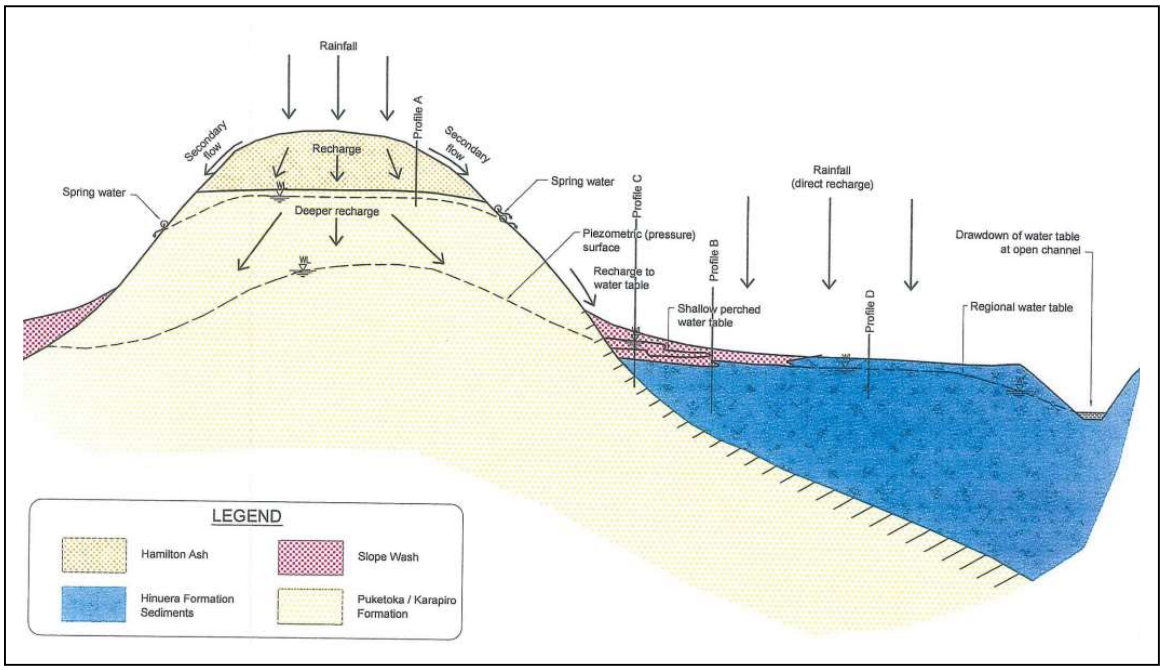


Figure 9 – Soil profile schematic[12]

Profile A

This soil profile comprises up to 5 m of orange brown, moderately plastic silty clay (Hamilton Ash) overlying deeply weathered, yellowish brown, pumiceous silts and sands (Puketoka Formation). Groundwater levels were typically at or slightly above the interface of the two formations.

These soils were encountered within the elevated ridges around the periphery of the catchment. The thickness of the overlying ash layer generally decreases with a decrease in elevation of the borehole within this area.

Profile B

Profile B comprises an upper layer of whitish brown, fine grained sandy silt of up to 2.0m thick overlying medium to coarse grained pumiceous and rhyolitic derived sand with finer grained sandy silt lenses (Hinuera Formation). The upper fine-grained sandy silt unit is likely to represent deposition of slope wash sediments derived from weathering and erosion of the elevated ridges.

Groundwater encountered within this profile comprises an upper perched aquifer within the overlying fine-grained soils and a deeper groundwater level with the underlying coarser grained soils. Type B soils are typically encountered around the periphery of the elevated ridges.

[12] From '*Te Awa O Kātāpaki Catchment, Assessment of Geology, Hydrology and Gully Stability*', Tonkin & Taylor, March 2004.

Profile C
Profile C soils are like Profile B except the bottom of the borehole intercepted a thick unit of blue grey, pumiceous silt beneath the coarser grained sands of the Hinuera Formation. This silt layer is likely to represent the underlying Puketoka/Karapiro Formation, which forms the basin into which the Hinuera sediments have been deposited.

Groundwater levels within this soil profile are typically shallow (<1.0m below ground level). Profile C subsurface soils are typically encountered close to the margins of ridges around elevation changes.

Profile D
Profile D soils are typically those associated with soil profiles within the Hinuera Formation. These underlie a thin silty topsoil cap, and generally comprise grey, medium to coarse-grained sands within thin lenses of fine-grained sandy silt.

Profile D soils are encountered in the flat low-lying area in the central part of the catchment and typically have groundwater levels between 1.0 m and 1.5 m below ground level.

Soil Permeability

Results of permeability testing indicate that near surface permeability does not vary much over the catchment.

- Profile A soils range from 1 to 3 x 10^{-6} m/s, which is classified as imperfectly drained (i.e. slow drainage) and typical of a silty clay soil.
- Profile B soil permeability ranges from 0.8 to 3.8 x 10^{-6} m/s which is imperfect to poorly drained (slow to very slow drainage) with the variability due to the presence of higher permeability lenses within the slope wash material.
- Profile C soils indicate a similar permeability to profile B soils since the controlling factors are generally the same.
- Profile D soils, although they comprise coarser grained, higher permeability sediments are generally overlain by a finer grained silty loam. Near surface permeability within this formation ranges from 2 to 7 x 10^{-6} m/s and can be classed as imperfect to moderately drained (i.e. average drainage).

For much of the catchment, the near surface permeability is not expected to be enough for complete disposal of stormwater. This is due to a combination of low permeability (3-25 mm/hour) and high seasonal groundwater. This may not be true for Profile D soils near the Waikato River, deeper sections of gully, or where the overlying loam is not of a significant thickness.

For areas close to the Waikato River, or deeper sections of the Te Awa O Kātāpaki Stream gully, disposal by soakage may be possible. This is particularly relevant for Profile D soils below the overlying loam soils.

Soakage should be investigated in all areas to determine soakage potential. This should include water table measurements and testing below the overlying loam layer in Profile D areas.

Soil Maps
Refer to Plan 005 in Appendix B for a soils map. Refer to Appendix D for additional geological information.

3.5 Natural Values[13]

Key Update	Key Mitigation	Conclusion
1. **The catchment is home to a number of native fish species including shortfin and longfin eels, banded and giant kōkopu, smelt, and black mudfish, few sensitive taxa/species are encountered in samples, including in the parts of the stream with good physical habitat quality.**	1. Improvements to existing stormwater devices, Implementation of in-stream and riparian enhancement works.	1. Programme of habitat restoration and enhancement is underway.
2. **Turbidity and suspended sediment are at concentrations that cause avoidance behaviour in fish and reduction in aquatic macroinvertebrate diversity, while increasing particulate metals and nutrient loads discharged into the aquatic habitat.**	2. Strengthening the effectiveness of erosion and sediment control measures on construction sites.	2. LTP programme of works to prioritise improvements to stormwater devices.

3.5.1 Terrestrial Habitat - Te Awa O Kātāpaki

Historically there were secondary succession alluvial vegetation (most likely kahikatea swamp forest), with mixed conifer-broadleaf forest on higher ground. Some small areas of peat bog vegetation and larger areas of lowland swamp vegetation existed in the low-lying areas in the upper catchment, and there were extensive swamplands in the gully floors associated with large spring and high groundwater flows.

Currently rural parts of the Te Awa O Kātāpaki catchment are almost entirely vegetated in exotic pasture, with exotic trees and shrubs planted as shelterbelts and hedges, or for amenity and animal welfare purposes (livestock shade). Much of this vegetation is currently being removed to facilitate development.

In developed and developing residential areas, the vegetation is comprised of a typical mix of native and exotic garden variety plants as well as open grass areas.

3.5.2 Terrestrial Habitat - River North

The River North sub-catchment is almost entirely in residential development except for an area south east of Joseph Lovett Lane. Part of this area is comprised of HCC reserve dominated by mown grassland.

The middle land parcel is pasture with large exotic deciduous trees including poplar and a portion that has been partly developed with a formed road.

The southern land parcel has been developed. Gully vegetation consists of regenerating native riparian species with a proportion of weed vegetation and natural channel.

3.5.3 Riparian and Aquatic Habitat – Te Awa O Kātāpaki

<u>North Rototuna</u>

[13] Te Awa O Kātāpaki Stream: Assessment of Ecological Values, Boffa Miskell, 2015

Most of the North Rototuna area inspected[14] was observed to have dark soils with visible organic matter, this included the soils observed at all the possible natural wetlands visited. Manaaki Whenua / Landcare Research describe the majority of the TAOK ICMP catchment, especially the North Rototuna area as imperfectly to poorly drained and classified as having orthic gley and orthic podzol soils. Orthic gley soils are chemically reduced soils that are strongly affected by waterlogging (chemical reduction is caused by high water tables that limit oxygen). Orthic podzols occur in areas of high rainfall and are usually associated with forest trees with an acid litter (possibly in this case, historic kahikatea stands) and are associated with slow permeability. These soils are typical of where wetlands have been located historically.

Land use within the areas that were visited was mainly farmland with pasture grassland and/or currently being planted for maize cropping. Some areas were also being developed with earthworks in progress at the time of the site visit.

As shown in Figure 8-1 below, there were eight areas (W1-8) that have been classified as natural wetlands in North Rototuna area. Classification, description and approximate area, together with locations and extent of each possible and confirmed natural wetland are provided in Appendix J.

Figure 10 – Possible natural wetlands located during Stage 2 ground-truthing of North Rototuna (W1-W8). The Map also shows modified watercourses (purple) and artificial watercourses (yellow) within the Te Awa o Kaataapaki catchment boundary (green), Tonkin and Taylor 2022.

[14] Tonkin and Taylor 2022; Hamilton City Council - Wetland and Watercourse Identification – Te Awa O Katapaki Integrated Catchment Management Plan, v.2 22 August 2022.

Any development that may impact on possible natural wetlands W1 to W8 will require a further WDP assessment to confirm status under the NPS-FM, and potentially an ecological assessment to inform an assessment of effects under the NES-F.

Urban Upper Catchment

The Tuirangi Floodway is straight and uniform, but the riparian margin and floodplain has been extensively planted. Aquatic macrophytes are abundant in the channel in some places. This results in greater aquatic habitat diversity than would usually be expected in an artificial system, because water flow is creating meanders, pools, and eddies around the overhanging and in-stream vegetation.

The Trinidad Place tributary has headwater wetlands draining down a small steep sided gully system to a confluence with the Tuirangi Floodway. The tributary has little natural riparian vegetation but is protected with weed species overhanging the channel. It has relatively natural meanders, and variation in water depth and flow. It may dry up or become intermittent in summer when flows and groundwater levels drop, but it is likely that some pools would remain as habitat refuges.

Southern catchment

Headwaters in the southern catchment have been piped and culverted and drain into the Te Awa O Kātāpaki main stem downstream of Magellan Lake. There are no surface waterways.

Lower Catchment

Magellan and Petersburg Lakes have been constructed as on-line stormwater devices and/or amenity features downstream of Magellan Rise and Petersburg Drive respectively. Both lakes have weirs at their outlets presenting potential fish passage barriers and are significantly different from the aquatic habitat that would originally have been present. The weirs have been authorised by WRC.

Refer to Plan 012 in Appendix C for a plan of the locations of the weirs.

Magellan Lake:

- The riparian and aquatic habitat at Magellan Lake was assessed as being poor.
- Aquatic macrophytes consist only of small clumps of bamboo spike sedge (Elecharis sphacelata) and no other aquatic or riparian vegetation is present.
- The lake margins consist of vertical block walls.

Magellan Lake downstream plantings

Riparian planting was undertaken by CDL along the reach of the TAOK Stream from the end of the stilling basin to the existing well shaded part of the stream (approximately 50 m) in April 2011. The stream reach immediately downstream of Magellan Lake was observed to be overgrown by exotic weed species. The immediate area downstream of the outlet of Magellan Lake (stilling basin) was overgrown with grey willow (*Salix cinerea*) (Photograph 1).

Photograph 1: Vegetation observed around the stilling basin downstream of Magellan Lake showing grey willow growing around the stilling basin.

In the area downstream of the stilling basin, there were sparse taller native species observed such as cabbage tree (*Cordyline australis*), *Comprosma robusta* and ponga/tree ferns. However, the area was mostly inundated with weeds and exotics of varying strata (herbs to tree species) (Photograph 2). There was also no evidence of any maintenance of the area. Because of the density of the large weeds and steep terrain, we did not access the understorey to assess the success of any understorey plantings.

Photograph 2: Vegetation observed south of the stilling basin downstream of Magellan Lake showing numerous exotic weed species.

Petersburg Lake:

- Petersburg Lake has planted vegetation around the margins which may eventually provide shade and woody debris.

- Lake appears to have variable depth, overhanging lake margin vegetation, and aquatic macrophyte beds.
- Although highly modified compared to the natural stream/wetland environment downstream, the lake appears to provide moderate to good quality aquatic habitat.

Middle reaches of the Te Awa O Kātāpaki Stream:

- The Te Awa O Kātāpaki Stream between Magellan Lake and Petersburg Drive (middle reach) is a modified habitat with water depth and channel width varying considerably along the main stem. Moderate aquatic habitat is provided.
- Active erosion and scour previously has occurred but bank stability has increased with the development of bank vegetation (observation 2016).
- Reaches include modified and straightened channels, as well as reaches with more natural meanders.
- Stormwater discharges are predominantly point source discharges from treatment devices rather than overland flow. Scour and sediment deposition was observed at some of these discharge points.
- Well-developed riparian and wetland vegetation, particularly the willow canopy and sedgelands, appears to have prevented large scale erosion and bank failure along the stream reach.
- Riparian vegetation along the true right bank is mostly intact but highly modified. Riparian vegetation comprises planted native areas and mixed native and exotic early succession shrubland and forest.
- Aquatic habitat diversity appears to increase with distance downstream, with pools and riffles present as well as undercut banks, logs, aquatic macrophytes and other organic debris.

Cumberland Drive downstream plantings

Planting work in this area was completed in August 2013. The riparian plantings of the watercourse immediately south of Cumberland Drive have been more successful than those downstream of Magellan Lake. Most of the native species have been able to prevent the invasion of larger exotic weeds (Photograph 3 and Photograph 4 below).

Photograph 3: Riparian planting along the watercourse immediately south of Cumberland Drive have been relatively successful (view from Cumberland Drive).

Photograph 4: Good growth of planted natives and few weed species.

Lower reaches of the Te Awa O Kātāpaki Stream:

- Downstream of Petersburg Lake, the stream flows through a deeply incised gully system with steep gully slopes and a well-developed floodplain.
- Stream has a natural meander and habitat diversity is moderate to high, with a range of habitats present including undercut banks, pool, riffle and run sections, aquatic macrophytes, root mats and large amounts of instream woody debris and particulate matter.
- Riparian vegetation cover is present over a high proportion of the lower stream reach in the form of early succession native and exotic shrubland forest, and dense sedgeland and swamp vegetation.
- Bank erosion and channel scour potential is being minimised with dense riparian and wetland vegetation. Cornes et al. (2012) has identified the lower reach of the Te Awa O Kātāpaki Stream gully system as a key ecological site, which is described as a mix of grey willow forest and kanuka/mahoe forest.

3.5.4 Riparian and Aquatic Habitat – River North

Three small first order waterways in the middle of the River North sub-catchment have shrubland or treeland riparian cover. All three waterways are likely to have been modified by past agricultural land use and current land development including impounding the waterway to create a pond, installation of stormwater infrastructure, vegetation clearance, channelization/diversion, and livestock access. The condition of the waterways has not been specifically assessed due to private access limitations.

The northern waterway is summarised by Boffa Miskell as follows:

- Small and relatively steep with a total waterway length of around 550 m.

- A piped upstream reach exists east of River Road. Stormwater from residential development and roads discharges into this waterway.
- The middle reach between the HCC reserve and River Road appears to be modified but generally follows natural topography.
- The downstream reach around the HCC reserve perimeter does not appear to be natural and may have been diverted from its original alignment.
- Riparian shrubland planting within the HCC reserve provides shade, bank stability, and organic material to the waterway.
- The waterway may be dry for part of the year.

Fresh Water Solutions (consultancy) carried out an assessment to support a subdivision consent application in August 2016. Their report summarised the following within the property:

- The instream and riparian habitat is in a highly modified state.
- The entire length of the watercourse is characterised by poor quality riparian vegetation dominated by pasture grasses, deciduous exotic trees, and blackberry, providing very little channel shading.
- The area downstream of the river road pipe outlet is typical of a scour zone and is characterised by sandy substrate and moderately turbid water.
- Downstream of the pond the watercourse is a mixture of artificially created channel and overland flow path covered by pasture grasses.
- Riparian margins of the watercourse within Featherstone Park have been planted and are well established.
- Water exists in deeper parts of the channel and upstream of a culvert within Featherstone Park where the geology changes to sand.
- The tributary is likely to be dry for parts of the year.
- The watercourse enters the river via a poorly defined channel amongst willows.

The middle waterway is summarised as follows:

- A small and steep waterway with a length of about 190 m.
- The waterway is almost completely modified for stormwater conveyance and treatment.
- The waterway is an armoured channel with rock riprap, covered geotextile or matting and planting.
- Part of the waterway has been converted to an on-line stormwater detention device.
- Sediment deposition into the riparian zone and/or channel from the adjacent earthworks has occurred.
- Riparian vegetation appears to be mixed shrubland and exotic trees.

The southern waterway is summarised as follows:

- Approximately 185m long and located in the base of a relatively unmodified gully.
- Riparian gully vegetation appears to consist of regenerating native riparian species with some weed vegetation, and the channel is likely to be largely natural.

- The waterway is subject to existing WRC resource consent conditions to manage effects on riparian and aquatic habitats.
- Based on the criteria of Cornes et al., the southern waterway riparian vegetation could be considered significant.
- The waterway requires field survey on the upstream half of the northern waterway and the middle waterway to determine actual instream values and fish passage barriers at the outlet to the Waikato River.

3.5.5 Water Quality – Te Awa O Kātāpaki

Key Update	Key Mitigation	Conclusion
1. Historic brownfield development did not require stormwater management until 2000, resulting in a portion of the catchment without treatment.	1. Redevelopment will require to meet the current standards and retrofit devices will be required.	1. Development standards are clear in the means of compliance table and a brownfield improvement programme of works is proposed in the LTP
2. An update to Hamilton's Infrastructure Technical Specifications (2013) resulted in preferred stormwater treatment generally changing from ponds to wetlands; new development will reflect current standards. Older devices do not meet current standards.	2. Prioritisation of improvements to existing stormwater devices,	2. Existing/older devices are prioritised for improvement subject to LTP funding and programming. Some improvements can occur under defects liability and regular maintenance. New devices are in some cases supported by LTP funding.
3. The ICMP recommends additional water quality measures in some sub catchments to support downstream devices (e.g. Bourn Brook swale in Rototuna).	3. Additional at source recommendations, including a recording and monitoring programme	3. Development standards are clear in the means of compliance table.
4. HCC's Stormwater and Receiving Environment Monitoring Programme will continue.	4. Inclusion of an additional monitoring site in Council's SREMP, upstream of Resolution Drive	4. Additional environment monitoring programme
5. Public education regarding edible aquatic plants and fish harvesting (i.e. where watercress collection may occur).	6. Proposed signage (at Magellan Lake) for public education regarding harvesting of fish and aquatic plants for consumption within the catchment.	5. Enhanced public awareness regarding harvesting of flora/fauna for human consumption.

Water quality is assessed against the ANZECC guidelines on the basis that they set thresholds for chronic exposure of aquatic organisms to existing contaminants (for discussion on use of ANZECC and USEPA guidelines see Te Awa O Kātāpaki Stream - Assessment of Ecological Values, 2016)[15]. Previous assessments

[15] TRIM link D-2148398 or Appendices

have been carried out in 2004 (Kessels & Associates) 2012 and 2013 (Tonkin & Taylor). An updated assessment was carried out in 2015 by Boffa Miskell Ltd (referred to below as the "ICMP Ecology Report).

In 2020 Morphum Environmental Limited carried out a site inspection of a number of existing devices within the catchment which has informed the key and residual issues table above.

Further in 2020 Tonkin & Taylor undertook a review of previous freshwater ecology information and current monitoring information for the Te Awa O Kātāpaki Stream and reported their findings in 2021. They also undertook a Watercourse and Wetland classification in accordance with the National Policy Statement for Freshwater Management 2020 (NPS-FM) and associated regulations, as the previous ICMP assessments were carried out prior to these legislative changes coming into force. Their findings are summarised below, and a full copy of both T&T reports are in Appendix J.

3.5.6 2021 Review of Freshwater Ecology findings – Te Awa O Kātāpaki Stream

The ICMP Ecology report presented the results of grab sample data (one or two sampling occasions) collected from four sites on the TAOK Stream. Additional data are available for the two online ponds present on the main TAOK stream (Magellan Lake and Petersburg pond). The data were collected for the purpose of assessing the effects of the ponds on stream water quality, primarily water temperature and dissolved oxygen.

Magellan Lake

Monitoring of the effect of Magellan Lake on TAOK Stream water temperature and dissolved oxygen was undertaken by T+T for the developer (CDL Land (NZ) Ltd). Continuous water temperature data were collected at locations upstream and downstream of the lake for two summer periods prior to and two summer periods after the lake was constructed. The results are presented in detail in the 2013 Magellan Lake environmental monitoring report2 and in an NZ Stormwater Conference paper5. In summary, for the post lake scenario and as of 2013 the broad upstream to downstream trend based on mean temperatures were as follows. Magellan Lake resulted in an increase in temperature in the TAOK Stream of up to 5 °C in summer. TAOK stream temperature then reduced by around 2 °C when mixed with the cooler water entering the stilling basin from the southern catchment. Further cooling then occurred through the shaded reach of the stream to Wisteria Place around 750 m downstream of the lake (0.6 to 0.9 °C). Continuous dissolved oxygen monitoring data collected by T+T downstream of the lake outlet indicated that while brief low levels in dissolved oxygen occurred, in general dissolved oxygen conditions were similar to or better in the post lake scenario (2012 and 2013 data) relative to the pre lake 2008 data. For example, the percentage of measurements below the slight effects' threshold for stream fauna of 6 mg/L (Maxted et al. 20056) was less in 2012 and 2013 (a drought summer) compared to in 2008.

In order to assist in mitigating any effect of the lake on stream dissolved oxygen levels it was proposed to incorporate rock lining into the lake outlet channel to break up flow and aid in oxygenating the discharged lake water. Monitoring of dissolved oxygen concentrations and levels upstream and downstream of the rock lined outlet channel of Magellan Lake showed a small but consistent improvement in dissolved oxygen conditions as a result of aeration of water discharged from the lake. On average conditions improved by 0.29 mg/L and 3.6 % saturation.

Petersburg pond

Monitoring of the effect of Petersburg pond (see Figure 8-2) on TAOK Stream water temperature and dissolved oxygen was undertaken by T+T for HCC as part of its CSDC monitoring programme. Continuous water temperature data were collected at locations upstream and downstream of the pond over the

013/14 summer period with data sondes deployed to monitor dissolved oxygen for one week each month during December 2013, January, February, and March 2014.

Figure 11 – Location of Petersburg Drive online pond

Temperature results showed little difference between upstream and downstream temperatures with comparable temperature ranges, maximum and minimum values and similar peak and troughs with overlapping temperature data. This may be due to the small size of the pond resulting in a short residence time reducing the opportunity for water to be heated during the day. The dense beds of weeds (parrots feather) may also reduce the degree of mixing in the pond as there is generally a narrow and fairly direct flow path through the weed from upstream to the outlet. Essentially the stream flow may pass fairly quickly through the pond. Overall, the Petersburg Drive online pond appears to have little effect on water temperatures.

Dissolved oxygen levels increased slightly downstream, which is likely due to a combination of factors including, maintained water temperature and the rock lined fish pass at the outlet of the pond causing turbulent flows and water to become aerated. Small rainfall events also appeared to cause dissolved oxygen levels to improve slightly upstream and downstream of the pond. Upstream and downstream dissolved oxygen levels were generally below the 6 mg/L slight effects criterion and occasionally fell below the 4 mg/L moderate effects criterion[6]. This means that dissolved oxygen conditions were likely to be having a slight to moderate effect on aquatic life.

3.5.7 Habitat and sediment quality

Stream habitat and sediment quality data have been collected from five sites on the TAOK Stream since 2013 as part of HCC's CSDC monitoring programme. Site locations are shown as T1 to T5 on Figure 8-3. All five sites were monitored in 2013, with selected sites monitored in 2019 and 2020 following a change in monitoring approach and a shift to prioritised monitoring. Monitoring comprises a qualitative habitat assessment (QHA) undertaken over a 100 m reach in accordance with WRC's Regional Guidelines for Ecological Assessment of Freshwater Environments, collection of a single macroinvertebrate sample and collection of a composite sediment quality sample.

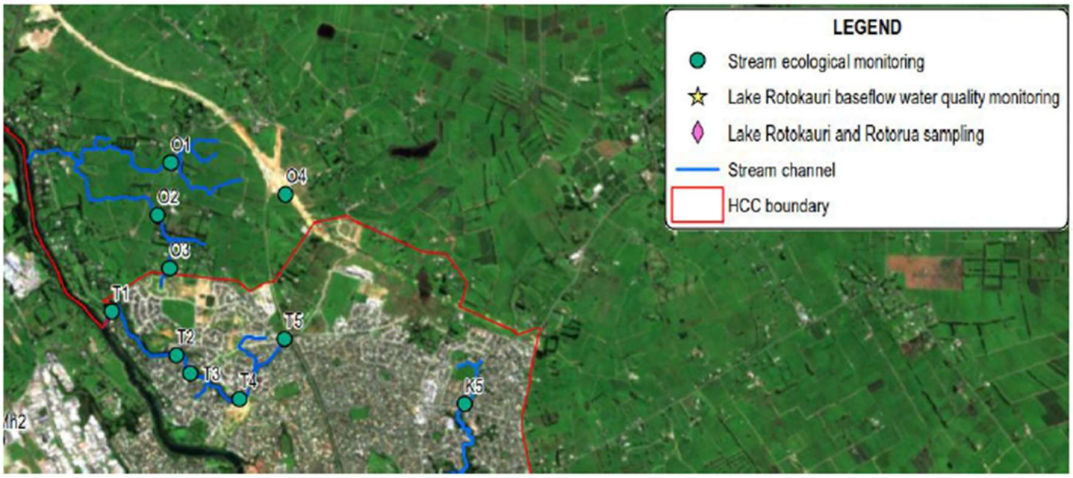


Figure 12 – Location plan extracted from HCC's SREMP and showing existing TAOK monitoring site locations (Sites T1 to T5).

Stream habitat assessment and macroinvertebrate data for each site in the TAOK Stream catchment are summarised in Table 2-1. QHA scores have remained approximately similar over time at Sites T2, T4 and T5 while there has been a reduction at Site T1. There was some sign of improvement at Site T1 from 2019 to 2020. Macroinvertebrate data for Site T1 show variable trends although Macroinvertebrate Community Index (MCI) and Quantitative Macroinvertebrate Community Index (QMCI) scores were low in 2020 compared to the first CSDC monitoring round in 2013.

Table 2-1: Macro-invertebrate sample results for TAOK Catchment habitat assessment sites

Site	T1			T2		T3	T4		T5		
Year	2013	2019	2020	2013	2019	2013	2013	2019	2013	2019	2020
Qualitative habitat assessment score*	116 (HB)	78 (HB)	83 (HB)	152 (SB)	151 (SB)	100 (SB)	154 (SB)	144 (SB)	69 (HB)	74 (SB)	79 (SB)
Number of taxa	9	15	12	5	16	8	7	8	6	17	17
Number of EPT taxa	0	1	0	1	0	0	0	0	0	0	0
MCI score	67	77	55	80	63	63	74	65	67	71	86
QMCI score	3.90	3.03	3.32	4.10	2.28	3.50	2.10	3.30	3.50	2.98	3.13

* HB = Hard Bottomed, SB = Soft Bottomed

MCI and QMCI scores for TAOK catchment sites have been low in general over time and mostly fall within the "poor" water and habitat quality class (below 80 for MCI and below 4 for QMCI). Few sensitive

Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa are encountered in samples, including in the parts of the stream with good physical habitat quality. This suggests an impact due to sedimentation and water quality issues.

QHA and macroinvertebrate data are also available for a site in the upper TAOK catchment which was investigated in June 2020 as part of a proposal to pipe the section of the TAOK Stream downstream of North City Road[3]. The QHA score for the site was 72 (out of a possible 180), MCI score was 73.6 and SQ-MCI was 2.2. Habitat conditions reflect the open nature of the site and macroinvertebrate data are indicative of reduced water and habitat conditions, consistent with the CSDC data for TAOK Stream.

Sediment quality testing results for samples collected as part of the CSDC monitoring programme are presented in Table 2-2. Results include extractible (E) and total recoverable (TR) copper (Cu) and zinc (Zn). Extractable metals (Cu and Zn) are for the <63 µm fraction following a weak acid digestion. The clay/silt (<63 µm) fraction is more likely to adsorb organic and metal contaminants and particles <63 µm are more common in the gut of sediment-ingesting biota. Concentrations have been compared to the ANZG 2018[9] default and upper guideline values.

Table 2-2: Copper and zinc concentrations in sediment collected at TAOK Catchment habitat assessment sites

Site	T1			T2		T3	T4		T5		
Year	2013	2019	2020	2013	2019	2013	2013	2019	2013	2019	2020
E Cu (mg/kg dry wt) [63um Fraction]	12.3	8.3	11.6	10.8	14.0	19.8	27.0	21.0	10.2	13.3	21.0
TR Cu (mg/kg dry wt) [500um Fraction]	7.6	8.7	15.6	6.8	6.8	8.3	5.2	10.4	5.0	8.1	12.7
E Zn (mg/kg dry wt) [63um Fraction]	137	76	168	126	160	199	174	101	83	82	102
TR Zn (mg/kg dry wt) [500um Fraction]	95	62	230	93	109	74	50	68	47	53	79

Orange text denotes values exceeding the ANZG 2018 default guideline values (DGV) of 65 mg/kg dry wt (copper) and 200 mg/kg dry wt (zinc).
Red text denotes values exceeding the ANZG 2018 upper guideline values (UGV) of 270 mg/kg dry wt (copper) and 410 mg/kg dry wt (zinc).

Few exceedances of ANZG guideline values have been detected to date, other than at Site T1 for TR zinc in 2020 which is consistent with the data reported in the ICMP Ecology Assessment. However, most sites where repeat monitoring has been undertaken, and in particular Sites T1 and T2, show a pattern of increasing recoverable and extractable copper and zinc concentrations over time.

The ICMP Ecology Report identifies metal contamination of watercress as a potential human health risk (in particular arsenic). The report recommends that additional sediment quality monitoring is undertaken at publicly accessible sites with watercress (i.e. where watercress collection could occur). Key analytes are arsenic and zinc.

3.5.8 Fish – Te Awa O Kātāpaki Stream

Additional fish survey information available for the TAOK catchment to that presented in the ICMP Ecology Report was reported by Tonkin & Taylor (February 2021) in Appendix J and is summarised below.

Online ponds

A fish survey was undertaken at Magellan Lake in early April 2014. Native fish captured comprised shortfin eel (*Anguilla australis*) and banded kokopu (*Galaxias fasciatus*). Exotic species captured comprised catfish

(*Ameiurus nebulosus*) and rudd (*Scardinius erythrophthalmus*). The presence of catfish and rudd were new records for the lake and the upper catchment at that time. Koi carp (*Cyprinus carpio*) and mosquitofish (*Gambusia affinis*) were not captured during the survey although both species are known to be present in Magellan Lake.

The smallest eels captured in the lake were 150 mm in length. Shortfin eels of this size are likely to be around 3 years old and their presence suggested that eel recruitment to the lake had occurred via the fish pass since the weir became operational (August 2010). The small size of the specimen (60 mm) suggests that the banded kokopu has entered the lake from the downstream catchment via the fish pass.
A similar fish survey was undertaken in Petersburg pond in April 2014 as part of HCC's CSDC monitoring programme[7]. Seven species of fish were caught during the online pond survey including four native species and three exotic species. Native species included shortfin and longfin eel (*Anguilla dieffenbachii*), giant kokopu (*Galaxias argenteus*) and smelt (*Retropinna retropinna*). Exotic (pest) species included catfish, rudd and gambusia.

Upper catchment
Fish survey data are also available for a site in the upper TAOK catchment which was investigated in June 2020 as part of a proposal to pipe the section of the TAOK Stream downstream of North City Road[3]. The only native fish species encountered was shortfin eel. Catfish and gambusia were also captured.

Mudfish
Mudfish were recently discovered in an upper tributary of the TAOK Stream as part of routine fish survey/ rescue work for the Waikato Expressway: Hamilton Section construction project. The Project alignment crosses many watercourses, including known and previously unknown black mudfish (*Neochanna diversus* - At Risk: Declining[11]) habitat. As the project footprint crossed known black mudfish habitat, a Mudfish Management Plan (MMP) was required prior to construction to provide an approved approach to mudfish management. The MMP was approved by Waikato Regional Council (WRC) and finalised on 7 July 2016.

An unknown, and previously un-surveyed population of black mudfish were found inhabiting a watercourse (culvert L) bisecting the project alignment near Kay Road (WGS 1984 coordinates: -37.71225556, 175.2594389). Fishing pre-culverting works resulted in 45 black mudfish being relocated downstream of works between December 2017 and January 2018. The black mudfish discovery and relocation sites are shown on Figure 8-4. Mudfish were confirmed to be present at the relocation site in late 2020.

Figure 13 – Mudfish fishing and relocation sites in an unnamed tributary of TAOK stream for the Waikato Expressway: Hamilton Section project.

Fish passage

Fish passage in the TAOK Stream system was assessed as part of a city-wide investigation undertaken as part of HCC's CSDC monitoring programme[7]. A total of 7 structures were inspected in the TAOK Stream.

The culvert beneath River Road at the bottom end of the catchment was upgraded in 2013 to include a fish friendly design and is no longer a barrier. The next two in-stream structures are associated with on-line stormwater detention ponds (Petersburg Pond and Magellan Lake). The outlets for both ponds include specifically designed and consented fish passes. The Magellan Lake fish ramp was specifically designed to allow the passage of eels based on habitat conditions upstream of the lake.

Only 1 barrier was identified in The TAOK catchment and this comprises a gabion weir located in the bed of a drain upstream of Borman Rd. The weir includes a 1.5 m vertical drop and low flows pass through the structure rather than over it. Habitat upstream of the weir comprises around 2 km of straightened farm drain and modified swales that would represent low quality habitat for eel species. The presence of a remnant mudfish population in the upper catchment also means enhanced eel passage is not desirable. For these reasons the barrier is not recommended for remedial work or removal.

Fish passage issues and priorities were more recently assessed by HCC in 2019 as part of the Stormwater Master Plan Version 2 project. There was no change to the priority for barrier remediation in the TAOK catchment. This is in contrast to the fish passage recommendations in the ICMP Ecology Report, and as a result, there is no longer any fish barrier removal proposed in the ICMP.

3.5.9 Fish - River North

Due to access limitations, fish surveys were not undertaken in the River North waterways and there is no existing FFDB data specifically for these waterways. Freshwater Solutions (consultancy) did not carry a

fish survey in August 2016 but their report notes that native fish present within the pond should be relocated prior to works in the watercourse.

Boffa Miskell considers that there is likely to be ecological significance based on being first order waterways. While Boffa Miskell recommend fish surveys of the middle and northern waterways to gain a better understanding of the habitat values, confirm ecological significance status, and inform appropriate management approaches, Council is not planning to undertake further fish surveys and instead expects these will be picked up at the time of consenting through ecology assessments prepared by developers.

The majority of greenfield areas in the River North catchment are now developed. The catchment has very few watercourses draining to the river and soakage is very good. There may be future opportunities to 'daylight' previously piped watercourses. This future opportunity is proposed to be captured in the Overland Flow Path data set.

3.6 Cultural and Archeological significance

Key Update	Key Mitigation	Conclusion
A Cultural Impact Assessment prepared for the Rototuna Structure Plan (NAMTOK, 2005) has described tangata whenua historic use and occupation in the wider structure plan area. Of note are several borrow sites and pre-European sites along the banks of the Te Awa o Kātāpaki stream. Increased erosion and scour are anticipated in the stream and works to stabilize these high-risk areas may impact on known and unknown archaeological sites.	1. City wide inventory and mapping of archaeological sites and sites of cultural significance updates earlier investigations (District Plan Change 9 - 2021). 2. Undertake specific archaeological assessment on lower reaches of the Te Awa O Kātāpaki stream where erosion protection works are proposed. 3. On-going engagement and cultural monitoring of sites of significance during erosion protection works. 4. Application of Heritage NZ archaeological authority conditions (if any)	1. Increased awareness and engagement with mana whenua regarding known and previously unknown archaeological sites, coupled with obtaining necessary archaeological authorities will complement the existing and historical traditional knowledge and occupation within the catchment. 2. Assessment of risk to these sites can be confidently undertaken ahead of Council's proposed erosion protection works.

Council commissioned NAMTOK, as the mandated representative of Tangata Whenua, to provide a report on the cultural significance of the Te Awa O Kātāpaki area to Maori. This report was provided to Council in May 2004, excerpts from which are included below.

The catchment is recognised as having significant cultural value. The catchment area is deemed to be part of the traditional land holdings of Ngāti Wairere. An area named Te Totara is located close to the bend on the Waikato River; south west of the intersection of River Road and Brywood Rise (previously called Sylvester Road). Te Totara was a well-known landmark to pre-European Maori and was historically used as a papakainga (unfortified village).

There are no surface features of Te Totara standing but there are many borrow pits in the area. This indicates that in pre-European times there was a significant Maori population living and cultivating crops. It is likely that there are structures and artefacts still buried in the soils of the area.

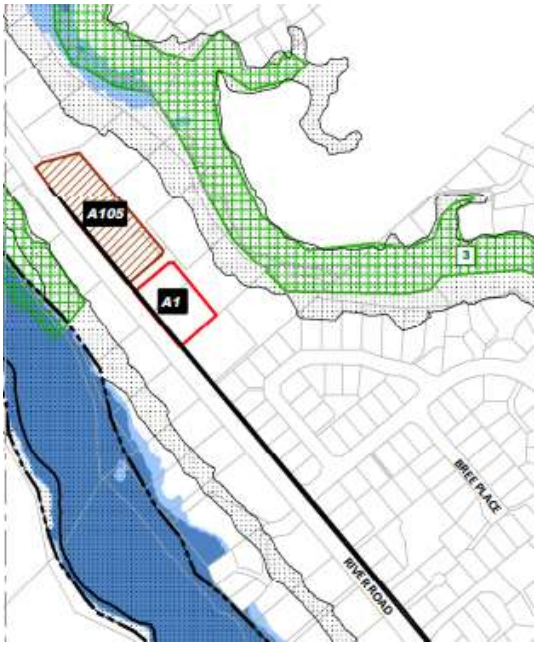
Of relevance to the Te Awa O Kātāpaki gully is that it was a Maori custom to bury koiwi (the bones of ancestors) in caves in the bank of such gully systems. If koiwi are present any modification of the gully system by earthworks or increased erosion may lead to such burial caves being disturbed.

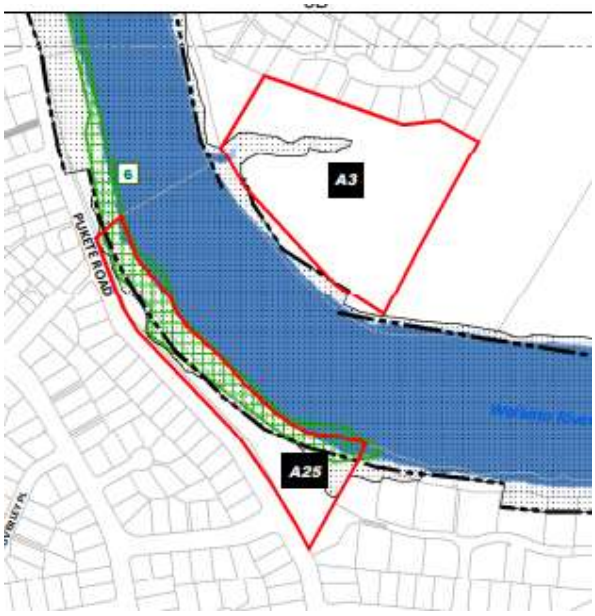
Following consultation with a representative of NAMTOK on 16 February 2006 it was identified that the Te Awa O Kātāpaki Stream is also important to local Iwi as a traditional fishery. In the past, eel weirs were erected in such streams. There may still be evidence of these structures in places along the Kātāpaki Stream.

It is important that these cultural values are understood, and cultural sites are protected when/if found.

Within the catchments, four cultural sites are identified in the Operative District Plan. These are:

- A1 - Te Awa O Kātāpaki Borrow Pits (S14/165)
- A105 - Te Awa O Kātāpaki Borrow Pits (S14/165)
- A12 - Owhango Pa (S14/25, S14/28)
- A3 - Te Totara Papakāinga (S14/189) – note A25 is on the opposite side of the Waikato River, outside of the Te Awa o Kātāpaki catchment





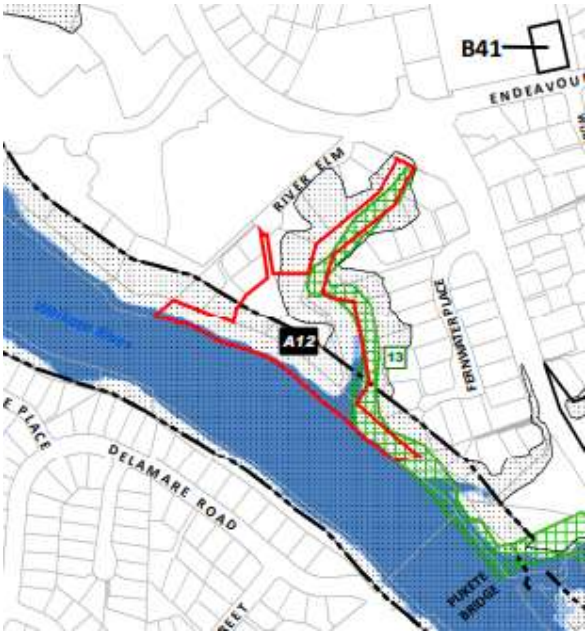


Figure 14 – Operative District Plan Maps (2017) Maps 8B, 16B and 17B (red outline)

As part of the District Plan Change Programme (commenced in 2021) Council has undertaken a city-wide update of archaeological sites and cultural sites of significance, including within the ICMP catchment. An updated inventory is being prepared for the District Plan. Council has also engaged mana whenua to prepare an updated inventory of sites of significance, and it is expected this will be more publicly available in early 2022. Council's GIS maps are being generated to reflect this more recent information.

3.7 Amenity, Recreational and Aesthetic values

The catchment has been identified as having values relating to natural green linkages. The Te Awa O Kātāpaki Stream flows through part of the Rototuna Structure Plan area before entering the Waikato River, providing an important natural link within a rapidly urbanising area.

The Rototuna Structure Plan acknowledges the value of this central unifying feature and while identified as having a principal stormwater function it is also recognised as a key green amenity corridor and shared walkway/cycleway connecting nearby neighbourhoods. The Rototuna Design Guide refers to the importance that the central drainage reserve/watercourse and associated green corridor is designed as an attractive feature, and that amenity values are enhanced.

The stream provides an important stormwater conveyance purpose that services the wider Rototuna urban area. It is important that future flows are managed appropriately to maintain the stream, especially in terms of bank stability and erosion.

3.8 Utilities and Services

Since 2000, there has been significant residential development within the catchment. Larger developments have been required to provide their own stormwater mitigation.

Appendix F shows the type, number, design details and design requirements of existing and proposed devices (excluding the piped network) in the catchment. There are other minor stormwater features such as soakage devices attached to catchpits that are recorded in the City Transportation Units RAMM database.

3.8.1 Existing stormwater network

Lower Catchment

Stormwater in the Lower Catchment is predominantly collected via piped networks discharging directly to the Te Awa O Kātāpaki Stream. Some areas close to the stream utilise soakage for primary disposal with overland flow to the stream in larger events.

Since the original catchment management plan was developed in 2006, there has been large scale residential subdivision. Each of the larger developments provide a stormwater mitigation feature most commonly in the form of treatment and detention ponds to deal with stormwater generated on -site.

The Te Awa O Kātāpaki Stream discharges to the Waikato River near the intersection of River Road and Kay Road.

Upper Catchment

The upper catchment is drained by a network of artificial farm drains which convey flows towards a central modified watercourse which serves the western side of the catchment or towards Borman Road, which has been historically piped. Developed areas discharging to Borman Road are collected in piped systems connecting to the Borman Road pipe. The systems associated with each development typically provide stormwater mitigation in the form of detention ponds or wetlands prior to discharge to the piped network.

Soakage is not generally used for primary disposal in the Upper Catchment mainly due to a high seasonal water table and/or poor soils, however some areas have been provided consents on this basis. Borman Road utilises soakage chambers that operate when conditions allow but primary disposal is via the piped network.

The central watercourse within the Rototuna Town Centre area (Refer to Plan 012 in Appendix C – stormwater feature 14) has been modified between the Expressway and North City Road, into a linear swale which serves an attention function. Between North City Road and Borman Road, the watercourse is considered a modified watercourse. This modified watercourse continues between North City Road and Borman Road. Both the Borman Road pipeline and the Bourn Brook swale join in the vicinity of the Resolution Drive and Borman Road intersection. They drain via the Tuirangi Floodway into Magellan Lake before continuing into the lower Te Awa O Kātāpaki Stream.

Southern Catchment

A large diameter stormwater pipeline collects water in the southern catchment from Hukanui Road westwards to Discovery Drive discharging into the Te Awa O Kātāpaki Stream near The Link. Urban housing areas have been developed with direct connections to piped stormwater network in each street.

Soakage is not used in the Southern Catchment which was developed at a time when soakage was rarely considered.

River North Catchment

The River Road North Catchment runs north-south between the Waikato River and the Te Awa O Kātāpaki Catchment.

The northern section of the catchment is a narrow line of properties which naturally drain away from River Road to the Waikato River. Properties in the northern section discharge their stormwater directly to the Waikato River independent of each other.

The southern section of the catchment from Featherstone Park south widens into a terraced formation that is drained by three overland flow paths (minor gullies and natural drains) directly to the Waikato River.

Attenuation would not normally be required for direct discharge to the Waikato River. In such cases stormwater management devices are only required for treatment purposes. The gullies would need to be assessed in detail at the planning stage to determine if attenuation is required to mitigate increased runoff volume and erosion potential in small local gullies.

3.8.2 Major Stormwater Features

Existing devices

A review of 19 existing stormwater management devices was undertaken (Morphum October 2020). The devices were assessed at a high level for performance and operation within the catchment. These are shown in the figure below.

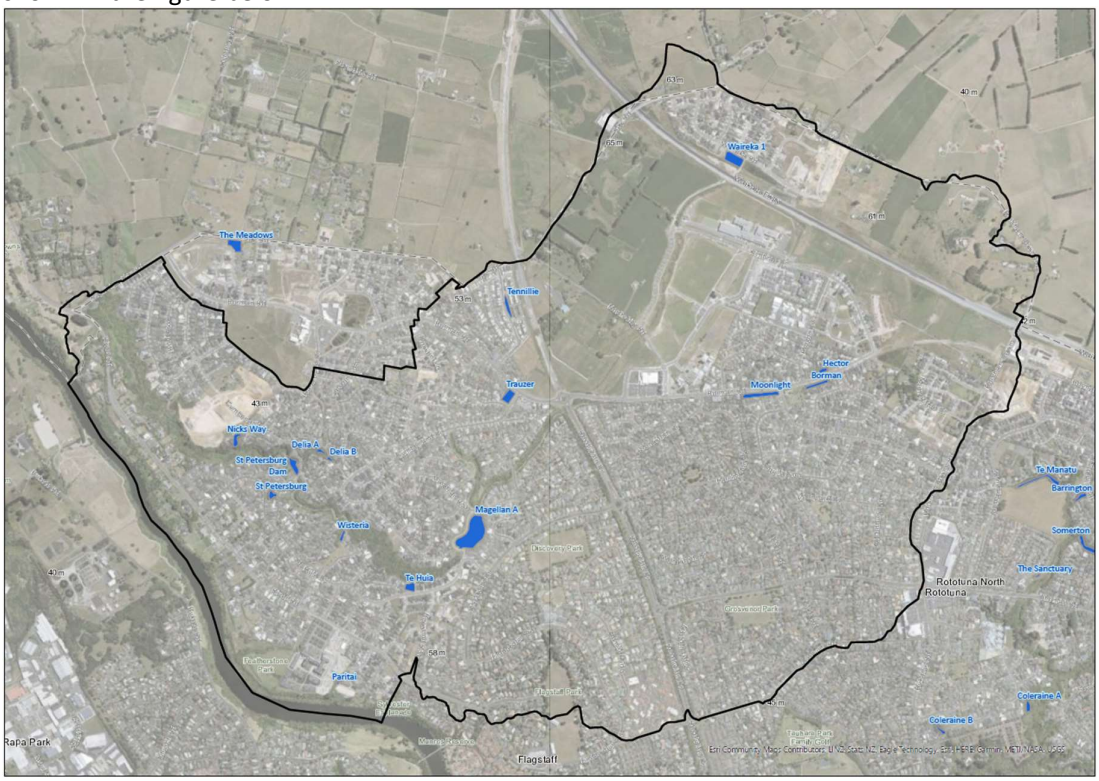


Figure 15 – Reviewed existing Stormwater Management devices in the catchment.

The review recommends several capital improvements ranging from conversion of on-line lakes to wetlands, through to clearing of invasive weed species and additional riparian planting. The projects have been assessed using multi criteria analysis and prioritized accordingly.

Bourn Brook Swale

This on-line stormwater management device serves the Upper West catchment and was originally designed to provide treatment and 2 and 10yr attenuation (co-incidentally the design also provides up to 100yr attenuation). The swale does not meet current contaminant removal standards and additional stormwater management devices are required targeting water quality treatment, for all development areas in the Upper West catchment draining to the Bourn Brook swale. Since its establishment, the swale now reflects a more naturalized watercourse.

Tuirangi Floodway

Cumberland Drive was designed to function as an overland flow path for development to the north. Excess flow from the 100-year storm event was originally intended to pass along Cumberland Drive and into the original stream now known as the Trinidad Tributary. CDL Land New Zealand Ltd. was granted approval to fill and realign a section of the upper Te Awa O Kātāpaki Stream above Magellan Lake. The main watercourse now flows through the Tuirangi floodway from Borman Road which was formed as part of the CDL realignment.

The Tuirangi floodway serves the upper catchment and was designed for conveyance only. The floodway did not have specific treatment, attenuation, or habitat functions. Planting was part of the floodway project and after some years the floodway now has some ecological value but remains a highly modified section of the stream, particularly due to its straight alignment. Refer to Section 3.5.

The Cumberland Drive overland flow path is no longer required because the flood conveyance function of the original stream alignment has been superseded by the Tuirangi Floodway. Cumberland Drive and the Trinidad Tributary still receive local discharges and overland flows, but do not service wider development in the upper catchment. Compensatory planting was carried out in the Trinidad Tributary between Cumberland Drive and Tuirangi Street.

The Tuirangi floodway has been modelled based on maximum development with climate change. The ICMP requires that all development discharging to the floodway and on to the lower stream is attenuated to pre-development flows rates for the 2-year and 10-year ARI storm events. The upper east catchment is required to be attenuated to 80 % of the pre-development 100-year ARI peak flow for the purpose of mitigation in the Borman Road area. The upper west catchment areas do not require 100-year ARI attenuation. Refer to Appendix C Plan 013.

Flood modelling has shown that the floodway can convey a future 100-year storm event within its footprint. The maximum extent of flooding in the floodway does not extend into private property.

Culverts

There are six culverts on the Te Awa O Kātāpaki Stream downstream of and including the Borman Road culvert. Refer to Appendix C Plan 012.

The River Road culvert is a large culvert under River Road in the lower catchment. The River Road Culvert is a 4.0 m high by 3.5 m wide concrete box culvert designed to pass a future 100-year ARI event. The waterway area is about 3.5 m by 3.5 m and fish passage and habitat is incorporated.

The original basis of design for the other culverts is not known. It is expected that they were designed to cater for at least a 50 Year ARI event with overland flow for the 100-year ARI event because they are all relatively new. Modelling has shown that all but one of the major stream culverts can pass the 1 % ARI event without overland flow. A stone arch culvert on Petersburg Drive will surcharge and flow overland in the 100-year ARI event. None of the culverts are known to impede fish passage.

A new 1500 mm diameter culvert under the Waikato Expressway will provide 100-year ARI conveyance from the upper Expressway catchment with 0.5 m freeboard[16]. The pipe size assumes unmitigated fully developed flow. Offset storage will be provided for and owned by NZTA. The offset storage will only serve the expressway section and will not provide any storage for the upper catchment areas. The upper catchment above the culvert will require land levels to be raised, 0.5 m freeboard to buildings, and 100-year ARI attenuation to manage increased flooding potential on the unconstructed part of Borman Road.

Magellan Lake

Magellan Lake is described as an on-line stormwater treatment pond used to attenuate flows from existing and proposed residential subdivisions. The lake includes a low flow spillway and fish pass enhanced with hand placed rock to reduce velocity and enhance hydraulics suitable for swimming fish species.

The lake was designed and consented to service 74 Ha of CDL Lands (residential zoning) by providing treatment and attenuation. During the consenting and design process the decision was made to construct the lake on-line to the wider upstream catchment which is significantly larger (~ 400 ha) with a mix of existing residential, roading and future greenfield development areas[17].

The lake outlet weir was designed to retain a permanent water quality volume and control peak flows from CDL Lands development to within 5 % and 7 % of pre-development peak flows for the 2-year and 10-year ARI (average recurrence interval) critical duration events respectively (2009 design report). The design included several assumptions including:

- Pre-treatment via stormwater catchpits
- Soakage to land where soil types permit
- Ongoing maintenance to maintain efficiency
- Comparable treatment and attenuation by upstream development prior to discharge to the Lake

Design documentation states that, in addition to CDL Lands, a nominal area of development could be attenuated by the lake. Based on the information available in the design reports, the lake was designed on the basis that all undeveloped upstream areas would be attenuated to pre-development flows for the 2-year and 10-year ARI storm events. Following construction of Magellan Lake, a section of Borman Road east of Resolution Drive was constructed with catchpit filters and underground attenuation tanks.

An assessment was carried out by AECOM in 2015 to see what capacity Lake Magellan had for future development. The assessment included:

[16] The WRC consent requires 50-year ARI.

- CDL Lands (as the minimum area to be attenuated by the lake)
- Future Borman Road – extension of Borman Road eastward to Horsham Downs Road. (Most of this extension currently discharges to the lake. At the topographical catchment boundary, minor areas of road may be diverted into the catchment, but this is not significant in relation to the overall catchment size).
- Resolution Drive Extension – extension of Resolution Drive north to the proposed Waikato Expressway. About half of the proposed extension discharges to the lake and this is not proposed to change. The remaining part of the extension discharges north into the Otama-ngenge Stream catchment.

The existing section of Borman Road east of Resolution Drive is serviced by its own system that may need to be supplemented by the Lake. To assessing the lake, it was assumed that the existing Borman Road had enough attenuation. The balance of the catchment draining to the lake will need to be serviced by new devices capable of restricting discharges to pre-development.

The conclusion of the assessment was:

- Magellan Lake cannot provide attenuation for additional development in its current form. The lake also does not provide sufficient attenuation of CDL Lands but the impact of this shortcoming is likely to be negligible in the context of the overall discharge through the lake and there is little benefit in requiring CDL Lands to be retrofitted to provide more attenuation.
- The HCC detailed flood model has established that raising the existing weir for the purpose of increasing attenuation volume would result in an undesirable increase in flood level.
- A significant improvement in attenuation performance can be realised if the lake level is reduced. The scale of the improvement is such that CDL Lands could be considered to be adequately attenuated, additional development could be attenuated in the lake up to about 40 hectares in addition to CDL Lands, there will be an overall reduction in downstream flow rates for 2-year and 10-year storm events.
- If the lake is drained, peak flood levels will not be negatively impacted provided the existing weir height or width is not made higher or narrower respectively.
- The modelled reduction in flood level was not significant enough to consider raising the weir to provide additional attenuation capacity and serviceable land area.
- If the lake could be converted, there was enough confidence that the Borman Road and Resolution Drive extensions can progress based on them being attenuated in the drained lake. The total area of HCC major road discharging to the lake, including existing Borman Road, is much less than the 40-hectare maximum additional service area yielded in the AECOM assessment.
- Any modifications that will change the hydraulics of the existing discharge weir are not recommended.
- If the lake is not converted to a wetland, the 10-year ARI attenuation shortfall for the existing section of Borman Road may need to be addressed.

Table 3-2 – Magellan Lake Catchment Areas

Catchment	Area (Ha)	% of upper catchment
CDL Lands	64.1	15.6
Borman Road Extension	6.6	1.6
Resolution Drive Extension	3.8	0.9

Existing Borman Road	3.5	0.9
Upper Catchment Balance	333	81.0
Upper Catchment Total	**411**	**100.0**

In terms of quality, the lake was designed as an open water dominated system, with areas for emergent macrophyte zones, however, earlier trials to establish a submerged macrophyte plant community were unsuccessful. The existing design has the following water quality performance and operational issues:

- The lake is undersized for the large contributing catchment. This results in excessive pollutant loads (including sediments, nutrients, and heavy metals) and resuspension of settled sediments due to high velocity through flows.
- Lack of vegetation within lake to support treatment processes. This is due to a combination of the existing depth being too great for emergent vegetation and the water clarity being too low for submerged macrophytes. Other contributing issues could include smothering and soils being unsuited to support vegetation.
- No provision in design for preferential deposition of sediments or practical clean out.
- No shading of impounded water results in elevated temperatures within the lake.
- No variability in lake bathymetry allows preferential flow and short-circuiting.
- Depth of lake (>2 m) likely to result in seasonal stratification and strong temperature gradient with reduced dissolved oxygen due to anoxic conditions within a hypolimnion.

Building on the hydraulic assessment carried out by AECOM, a potential opportunity to optimise Magellan Lake (to improve water quality and detention capabilities) is being explored. This would require conversion of the lake into a segmented wetland-pond[18].

A Tonkin & Taylor report (2017) has provided an overview of options for enhancing the lake which is described in Section 11.5.

Future Road Project attenuation and volume effects

Two road extensions in the upper catchment (Borman Road and Resolution Drive) represent about 2.5% of the catchment area to the floodway (refer to Figure 16).

[18] In 2018 HCC consulted with residents regarding possible Lake conversion. This was not supported.

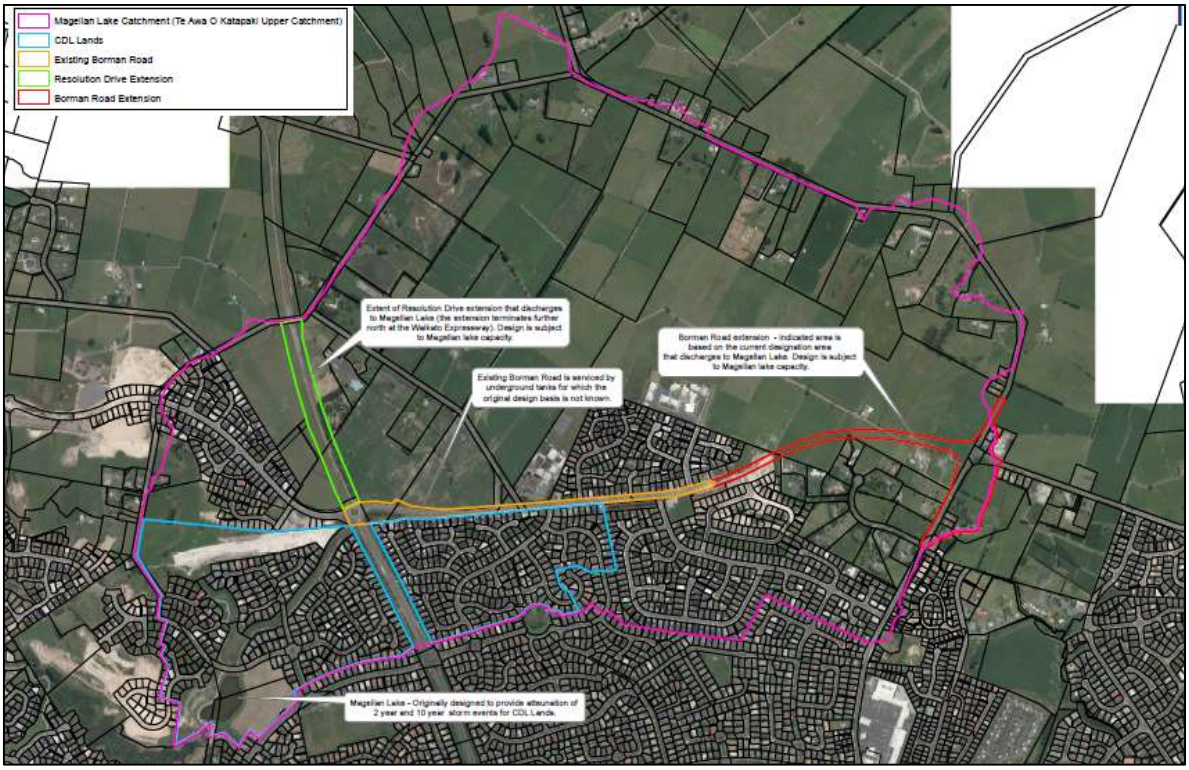


Figure 16 - Future major road extensions

Effects of roading projects on the floodway (and Lake Magellan) are summarised below:

- Extended detention and attenuation (2-year and 10-year ARI) is required prior to discharge to the Tuirangi Floodway. Extended detention and attenuation are required to protect the downstream environment and is consistent with the requirement for other development in the upper catchment.
- The proposed roads are a small portion (2.5 %) of the upper catchment; alone they will not cause a significant increase in flood levels and flows downstream. Runoff from Borman Road will have a fast response, most likely discharging to the Tuirangi floodway in advance of peak flows from upstream urban development runoff. Road attenuation requirements differ dependent on the part of the catchment they are in and the flood risk they present. For the upper Borman Rd Extension (between Kimbrae Drive and Horsham Downs Rd) 100-year flood attenuation will be required.
- For Resolution Drive the following applies:

Resolution Drive - Borman Rd to Tenille street Underpass[19]	2-year and 10-year storm event attenuation, treatment, ED and volume control in road corridor. Also allows for backup of 100-year overland flow from the Catholic school

[19] 300m north of roundabout

	catchment area (incase Cumberland outlet blocks). This section has now been consented based on the above criteria.
Resolution Drive – northern part after underpass between Borman Road and Kay road (discharges to Otama-ngenge)	100-year storm event attenuation (and treatment, ED, volume control). Note: this is required under the Otama-ngenge ICMP.
Other parts of Resolution Drive in the catchment that does not discharge to Borman road pipeline	2-year and 10-year storm event attenuation only (and treatment, ED, volume control).

- Runoff volumes will increase from all areas of the catchment, regardless of whether attenuation and extended detention is provided or not. The floodway could be at risk of some erosion because of increased volumes and durations of flows. This is typical of developed areas where large scale effective volume control (i.e. soakage) cannot feasibly be achieved. The roads are a small portion of the contributing catchment so effects will be minimal – soakage will be maximised if back of catchpit soakage crates are used like the existing section of Borman Road.
- Proposed treatment and extended detention, and intermittent soakage solutions will require technical approval by WRC under the City's comprehensive stormwater consent where this connects to the HCC network or will need to meet the conditions of the City's comprehensive consent and regional plan rules if it is a direct discharge to a watercourse.
- This ICMP recommends a project to reconfigure Magellan lake to improve its water quality performance and provide some attenuation for the Resolution Drive extension project.
- Flood Hazard Mapping carried out under this ICMP indicates that the Tuirangi Canal has enough capacity to convey this unattenuated water. Flooding of habitable floors is not predicted downstream of Magellan Lake with or without 100-year attenuation within the lake[20].

3.8.3 Existing wastewater network

Appendix F shows details for existing and future pump station and manholes and their levels of service. Refer to plan 011 in Appendix C for an indicative trunk network layout plan. Reference should also be made to the HCC Wastewater Master Plan which is the overarching plan for the development of major wastewater infrastructure. In part, the plan seeks to:

- Minimise whole of life cost of the construction, operation, and maintenance of the wastewater network.
- Minimise wet weather overflows of untreated wastewater to the environment.

[20] There is one house downstream near St Petersburg bridge that shows flooding of a habitable floor however, this potential flooding is mitigated with a retaining wall.

Te Awa O Kātāpaki

The existing wastewater network is a conventional piped system with pump stations to lift and transfer wastewater between gravity catchments. Areas of the catchment currently under construction and/or planning are the same. There are no interceptor (large diameter) sewers required in the undeveloped areas of the catchment. Undeveloped areas will discharge to the eastern interceptor via new and existing small diameter pipelines and pump stations.

The southern area of the catchment is typically less than 25 years old. Developed areas in the north are typically less than 10 years old. Relative low age and good condition means that the wastewater system does not have any known issues.

City wastewater modelling is consistent with the statement above. The wastewater network is not showing signs of stress anywhere in the catchment and pipe utilisation is generally low (<50%) under normal operating conditions. The main trunk pipeline from Borman Road to the eastern interceptor is predicted to flow full during wet weather because it is at a flat gradient, but it is not predicted to overflow (to 2061).

The Moonlight wastewater pump station was constructed circa 2007 to service the upper east catchment and has enough capacity to service anticipated development but will require additional storage. See Table 9-3 for details.

The new northern network has been designed and constructed to cater for all planned upstream development. Although the model is showing potential overflows in the future, based on the limitations described above there are no immediate actions required to service future demand. To eliminate predicted spill issues above and provide a more accurate assessment of the network, the northern Te Awa O Kātāpaki Catchment will need to be measured and calibrated in future model upgrades, once development is complete.

As part of Council's City-Wide monitoring and contribution to Te Ture Whaimana, incorrectly installed cross connections (wastewater to stormwater) continue to be investigated in the catchment and remedied when identified.

River Road North

The River Road North Catchment runs north-south between the Waikato River and the Te Awa O Kātāpaki Catchment.

The northern section of the catchment (north of Te Huia Drive) is a thin line of properties which naturally drain away from River Road, to the Waikato River. Those properties discharge wastewater on-site because there is no gravity wastewater system in River Road. They can do so because they are over 2500 m^2 in area which is the minimum requirement to comply with WRC rules for on-site wastewater discharges. These properties could be affected by subdivision and would need an alternative servicing solution if the proposed minimum lot size is less than 2500 m^2. Refer to Figure 29 to see properties that are not serviced by a primary system and have septic tanks. Wastewater options for further growth are provided in Section 7.

The southern end of the catchment from Featherstone Park south widens into a terraced formation. Part of the area is under development and a new pump station has been constructed (2014). The pump station known as Paratai (SPS 140) is not in a location which is suitable to service the entire block. A private pump

station is proposed to service the adjacent block which will be a private development (Refer to Plan 011 in Appendix C).

Another pump station that serves both Te Awa O Kātāpaki and Otama-ngenge (Rototuna West) has a limited size and will require additional storage and potentially another pump to service growth. Refer to Table 9-2 for details.

3.8.4 Existing water network

The catchment is located within the Rototuna supply area. Development to this catchment was the key driver for the construction timing of the Rototuna Reservoir. HCC are in the process of developing a water network strategy. This includes the dissemination of the reservoir and supply networks (currently combined) and the creation of zones.

Refer to Appendix C for an indicative trunk network layout plan. Reference should also be made to the current HCC Water Strategy and Water Master Plan.

3.9 Erosion and Scour – Te Awa O Kātāpaki

Key Update	Key Mitigation	Conclusion
1. **Stormwater volumes and run-off from the catchment into the stream, coupled with instability of stream reaches in key locations (between Magellan Lake and Petersburg Drive) are contributing to downstream erosion and bank scour. A programme of erosion prevention works has been developed in response to these works.**	1. Prioritisation and implementation of erosion prevention works by City Waters in accordance with LTP 2021-2024 allocation.	1. Works programme to minimise the effects of increased volume and downstream erosion and scour

An assessment of erosion and scour processes was undertaken in the following years:

- 2013 – erosion assessment (AECOM)
- 2015/16 – ecological assessment (Boffa Miskell)
- 2016 – preventative erosion assessment (Morphum and Tonkin & Taylor)
- 2017 – erosion mitigation (downstream River Road, MWH)

Figure 17 shows area of existing bank erosion.

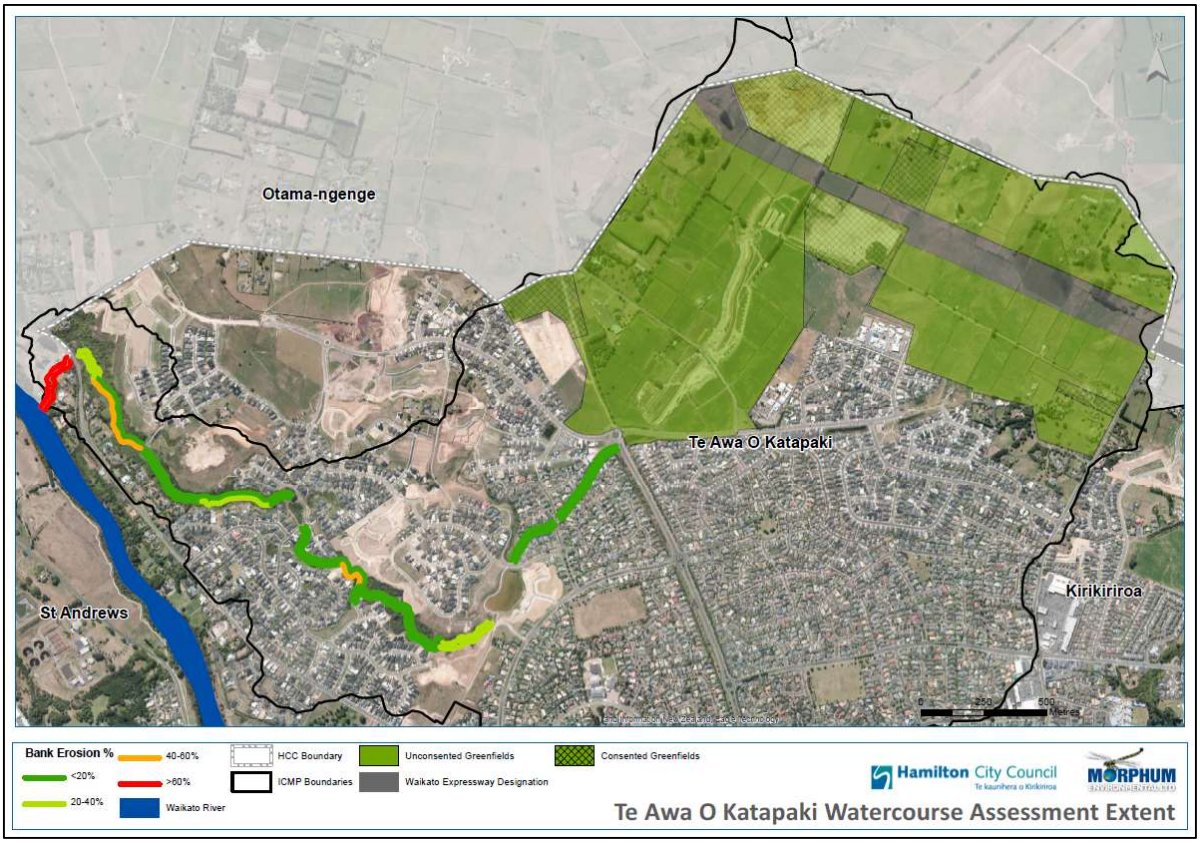


Figure 17 – Te Awa O Kātāpaki Watercourse Assessment - Erosion

3.9.1 Key findings of assessments

Upper catchment

Observations of the erosion and scour at the survey sites were consistent with swales that have been recently constructed and are still establishing. At the time of the survey the swale plantings were new and only beginning to establish. The upper swales were also being used as part of the sediment control system, so sediment was present.

The final form of the upper swales will be monitored as establishment occurs and the areas transitions from active development and earthworks to an operational conveyance and treatment system.

The Tuirangi Floodway and Trinidad Place reaches appear to be relatively stable, with little bank slumping, toe undercutting, or scour observed, but sedimentation was observed throughout the catchment. A 2016 assessment showed <20 % erosion.

Lower catchment

There is evidence of past slope failures over larger portions of the slopes in the narrow and steep areas of the catchment. These are likely to be related to a combination of groundwater seepage or where stream flow has eroded the toe of the steep slopes through the natural formation of the gully system.

Areas identified as having active instability or areas susceptible to instability and erosion in a 2004 assessment generally remain the same in later assessments. The stream bed appears stable and there is

no evidence of the channel meandering within the broad gully floor. Where active instability was observed, it typically related to areas where vegetation has been removed.

Instability within the catchment gullies is generally shallow retrogressive failure of the upper portions of the slopes or shallow slump type failures where the gullies are narrow and steep. Observed active slope failure is typically at the surface less than 1 m deep. Much of the observed erosion is typical of tributary gullies of the Waikato River within the Waikato Basin. Recent erosion and instability within these gullies generally relate to development where vegetation has been removed, concentrated flow exists, or where ground disposed stormwater exits at the crests of slopes.

At the time of the 2015 survey, the middle reach of the lower catchment downstream of Magellan Lake was experiencing scour and bank slumping over areas where willow canopy is not present or riparian planting is absent or recent. Subsequent observations early in 2016 indicated that this instability had stabilised due to the growth of weeds along the true left bank below the silt curtain, however, late in 2016, the watercourse assessment still showed potential for 20-60 % bank erosion. This supports an earlier assessment by AECOM which considered the effect of velocity on bank stability - see Figure 19.

The lower reach of the stream below the Petersburg Drive Lake is expected to be relatively stable based on observations of the dense sedgeland and willow vegetation upstream of River Road. This vegetation is expected to armour bank and bed sediments and was observed to be highly protective even after extreme rainfall events.

The reach between River Road and the Waikato River confluence (TAOK Main 1) is steep in places, has limited riparian margin and is experiencing significant erosion. Some existing erosion structures are present but further works are required. It should be noted that erosion in lower tributary streams of the Waikato River is attributed largely to degradation of the bed of the Waikato River.

The following figure shows reaches assessed in November 2016. Commentary is provided on the remedial works and/or riparian management requirements[21].

[21] Erosion Prevention Costing Te Awa O Kātāpaki- Morphum - Tuirangi Canal to River Road - 2017-05-24 (D-2301027)

Figure 18 – Erosion prevention stream sections

Table 3-3 – Erosion prevention works

Reach name	Description
TOK_MAIN1	Specific engineer designed solution completed
TOK_MAIN2	Vertical banks, 20-40% erosion, limited riparian margin **Recommended works include removal of noxious weeds, bank stabilisation, replanting on left bank, bank recontouring**
TOK_MAIN3	Erosion 40-60%, little or no riparian margin, noxious weeds, vertical banks **Recommended works include bank recontouring, stabilisation and planting**
TOK_MAIN4	Erosion <20% **Maintain existing native planting**
TOK_MAIN5	Narrow, steep, poor access, erosion 20% **Maintain existing native planting**
TOK_MAIN6	Steep, pest species, limited riparian margin, erosion 20-40%, poor access. **Recommended works include bank recontouring, stabilisation, riparian planting**
TOK_MAIN7	Steep, erosion <20% **Maintain existing planting**
TOK_MAIN8	Erosion <20%. **Maintain existing planting**
TOK_MAIN9	Erosion 40-60%, slumping, limited canopy, or understory vegetation **Requires riparian planting, hard engineering, and planting**
TOK_MAIN10	Erosion severe in hot spot **Recommended works include hard engineering, recontouring, and stabilisation with plants required**
TOK_MAIN11	Erosion 20-40% **Recommended works include obnoxious weed removal and replanting**
TOK_MAIN12	Steep, erosion 20-40% on upper banks but not works needed

3.9.2 Erosion Potential

Regions of the lower catchment with high modelled velocities, and where the gully is narrow with steep slopes have the potential for future instability. Mitigation in the form of physical works to prevent erosion is not practical due to the length of the steep gully system. See Figure 19.

Extended detention and volume control of initial runoff in all sub-catchments is recommended to reduce the long-term effects of higher development flows. Attenuation of the 2-year and 10-year storm event, to pre-development flow levels has been recommended for the upper catchment for consented developments to reduce peak flows and coincidence. Both recommendations are consistent with the 2006 CMP and RITS revisions.

Further impacts of growth on Te Awa O Kātāpaki downstream waterways have also been considered. A watercourse assessment was undertaken to inform concept projects for erosion prevention, based on existing stormwater discharges and proposed increases from growth. The assessment resulted in a funding allocation being proposed for erosion prevention in these watercourses[22].

Detailed options analysis and a planning assessment are required, including concept design of remediation and prevention options, to define erosion protection works. Planting is the preferred method of control as a pre-emptive measure as opposed to a reactive measure. Site assessments have shown that areas that are well planted are more stable than those that are not.

Monitoring of gully slopes and the condition of the channel is recommended to identify gully erosion if it occurs within the catchment. Areas of high velocity will be monitored more frequently and following significant events. Areas of known erosion or high potential, which coincide with an area of high velocity, will also be a focus for ongoing monitoring.

The River Road Culvert is expected to be a barrier between the stream and the Waikato River bed degradation. Downstream engineered erosion protection works should also assist. Fish passage will need to be monitored and maintained if the Waikato River continues to degrade.

[22] Refer to the Morphum Memorandum dated 16 February 2017 – Te Awa O Kātāpaki Stream – Erosion Remediation and Prevention Costing and HCC Stormwater Master Plan 2016

Figure 19 – Erosion monitoring areas

Key erosion areas are shown in Table 3-4. Areas not specifically identified will still be periodically monitored for general stability because much of the gully system is susceptible to soil creep, instability at seepages and concentrated stormwater discharges.

Table 3-4 – Key areas for erosion and stability monitoring

Area	Location	Comment
1	Tuirangi Floodway	High velocity downstream of Tuirangi Street culvert.
2	Magellan Lake outlet	High velocity at outlet structure. Potential erosion and/or soil creep.
3	Downstream of Magellan Lake outlet (to 500m)	High velocity due to incised stream. Potential slope failure by undercutting.
4	Stream section north east of Bentley Rise	High velocity due to incised stream. Potential steep slope failure and creep (via groundwater seeps).
5	Downstream of Petersburg Drive	High velocity through sharp bend and steep incised section. Potential steep slope failure and undercutting.
6	Downstream of River Road culvert	High velocities and bed profile steepening at interface with Waikato River. Erosion and undercutting are occurring. Construction has been undertaken for a permanent erosion remediation solution at this site at the time of writing[23].

[23] Review of the Erosion Issues - Te Awa o Kātāpaki Stream River Road Reach, Tonkin & Taylor Ltd, December 2018

Refer to Plan 004 and Plan 006 in Appendix B for an erosion and stability plan, and a stream flow velocity plan.

3.10 Overland Flow

Key Update	Key Mitigation	Conclusion
1. **GIS mapping, identification of overland low paths shows tour major overland flow paths requiring formation and protection.**	1. GIS mapping, identification, and protection of four key overland flow paths in the catchment at the time of resource consent assessment. 2. Properties south of Borman Road may require protection from overland flows in the event of pipe blockage.	1. Existing overland flow paths will be protected from build-out. 2. The Borman Road OLFP flood management project has been put forward to the LTP for consideration.

Overland flow is the route taken by stormwater flowing over the ground surface when the capacity of the primary piped system is exceeded or blocked. The overland flow path finishes when it enters a water body such as a stream or river. Stormwater runoff that exceeds the capacity of the primary system is required to be safely conveyed by overland flow paths.

Designated overland flow paths need to be incorporated into the design and layout of subdivisions to prevent localised flooding. Overland flow paths shall be provided to convey flows in excess of the design storm, up to and including the 100-year ARI event. Roadways will form secondary flow paths as far as possible. Where necessary, overland flow paths required over private land will be formally recognised and protected as part of the consenting and construction processes.

Overland flow modelled in developed areas of the Te Awa O Kātāpaki is limited to formal drainage channels during minor events and reserves during large events. Uncontrolled overland flow is not predicted anywhere in the catchment, subject to detailed development planning in the upper catchment.

Flooding is generally well contained in the lower catchment, so over attenuation of the 100-year event is not warranted for lower development (which has typically already occurred). This is consistent with the requirement of the structure plan.

Utilisation of the upper floodways is predicted to be at capacity but without adverse flooding. Borman Road will operate as an overland flow path upstream of the Tuirangi Floodway. An overland flow path alongside Borman Road links the low point to the Town Centre Floodway. Attenuation of the 100-year event in the eastern areas of the upper catchment is however proposed to minimise the risk of overland flow occurring along Borman Road.

3.10.1 Resolution Drive sub-catchment - Upper catchment

The Resolution Drive sub-catchment comprises 14.3 hectares of predominantly grazed pasture in the upper catchment. The sub-catchment is bounded by Borman Road to the south, existing residential development to the west, Kay Road to the north and existing farmland to the east. The sub-catchment's receiving environment is the Tuirangi Floodway and the Te Awa O Kātāpaki Stream via the existing stormwater network.

Figure 20 – Resolution Sub-catchment

Three options for managing overland flow for development from this area include:

- Low lying areas within the sub-catchment developed as sports fields (private), or similar use, for which occasional flooding is not an issue. Building platforms and floor levels would need to be adequately elevated. Overland flow would drain off site over the low point in Borman Road/Cumberland Drive intersection.
- Low lying areas within the sub-catchment could be filled to ensure overland flows are conveyed to the Borman Road/Cumberland Drive intersection without significant ponding and no increase in downstream flooding.
- A new pipeline could be constructed to convey flows to the Tuirangi Canal, designed to have sufficient capacity to convey the 100-year ARI flows from the full sub-catchment (including Resolution Village, Catholic Diocese Block, and the Resolution Drive road corridor).

A private drainage easement exists on two lots downstream of the Resolution Village site. The easement enables the Resolution Village site (Lot 2) to drain over the adjacent Catholic Diocese Block (Lot 1) to the south. The private easement could be relocated during development of the school site once suitable drainage facilities (piped and overland flow) are constructed. Details are provided in the Resolution Drive Sub-catchment ICMP (D- 1720221).

3.10.2 Borman Road Barrier – Upper Catchment

Construction of the Borman Road embankment west of Resolution Drive has created a barrier to the natural surface drainage path from the Resolution Drive sub-catchment located to the north. Frequent ponding of stormwater now occurs in the south-east portion of the site because runoff which would have previously drained south is now trapped north of Borman Road.

Secondary flow over Borman Road is estimated to commence at about RL 31.86 m. Stormwater will pond on the lower portions of the catchment in significant rainfall events or if the Borman Road culvert is blocked, before the secondary flow path provides relief. Ponding could be up to 1 m deep within existing low-lying land in the Catholic Diocese Block for the 100-year ARI event in a fully developed scenario.

The Borman Road barrier will need to be considered for all development within the sub-catchment when addressing overland flow and associated flood levels for building.

3.10.3 Borman Road East - Upper Catchment

The stormwater modelling undertaken in support of the TAOK ICMP suggests that the pipe below Borman Road has adequate capacity to convey the 100y MPD+CC mitigated scenario (although ponding in various sag points along the road are observed in the results). This scenario assumes flood attenuation in all new developments discharging to the Borman Road pipe.

It is noted that the final review of the TAOK stormwater modelling undertaken by Beca Ltd observed that the calculated flows reporting to this pipe were being under-predicted, which was acknowledged by AECOM (refer Item 5, Te Awa O Katapaki Stormwater Model Review dated 2 June 2017). Insufficient reporting currently exists to assess whether this would result in overland flow along Borman Drive under 'normal' network operating conditions.

An overland flowpath along Borman Road is still required under the current revision of the RITS to allow for failure of the pipe system, and this is currently reflected in the ICMP. Improvement works are recommended to maintain an overland flow path alignment for Borman Road which does not impact private properties.

3.10.4 Cumberland Drive Overland Flow

Cumberland Drive extends in an east west direction through recent development completed CDL Land NZ Ltd. (CDL). The upper reach of the Te Awa O Kātāpaki Stream was filled as part of the development works. Cumberland Drive now forms the major flow path (both piped drainage and overland flow) for a 42.5-hectare catchment extending to the north and east. The catchment comprises the undeveloped Resolution Drive extension sub-catchment (development of the road may divert flows).

The longitudinal grade of Cumberland Drive is flat which limits overland flow capacity. The road corridor has been designed to convey 100-year ARI peak flows from the fully developed upstream catchment. A report by Howes & Vink[24] shows flow depths (above the road centreline) in the order of 0.25 m to 0.55 m resulting in flooding of the road berms which generally extends beyond the road reserve and into the adjacent lots which were elevated to provide adequate freeboard to the building platforms.

[24] Howes and Vink Consulting Ltd. (HVC) CDL Land New Zealand Ltd, Subdivision Cumberland Drive, Rototuna - Cumberland Drive Overland Flow Path Modelling - Revision 02. 13 March 2012

Secondary overland flows from the Resolution Drive sub-catchment have been adequately catered for as part of the recent design and construction of Cumberland Drive. The provision of a direct discharge from the sub-catchment to the Tuirangi Floodway (for flows up to the 100-year ARI event), would reduce the scale and frequency of flow conveyed via Cumberland Drive (both piped and overland). Cumberland Drive would continue to provide overland flow relief if Borman Road were to be overtopped.

Details are provided in the Resolution Drive Sub-catchment ICMP (D- 1720221.)

3.10.5 Overland Flow from Otama-ngenge to the Lower Te Awa O Kātāpaki

The Otama-ngenge catchment has a >50-year overland flow path to the Te Awa O Kātāpaki stream in the event flow and volume exceeds the capacity of the Glaisdale West wetland primary outlet pipe and available storage, or if the outlet becomes blocked.

Overland flow from the wetland will discharge via a secondary overland flow path on Hare Puke Drive to the Eton Estate development to the south and on to the Te Awa O Kātāpaki Lower catchment. Modelling of the Hare Puke Drive overflow has been undertaken based on detailed engineering design documentation (prepared by MGSL). Discharge is governed by the centerline crown of Hare Puke Drive (approx. chainage 204 m) which forms the broad crest of the emergency relief 'spillway' for the wetland

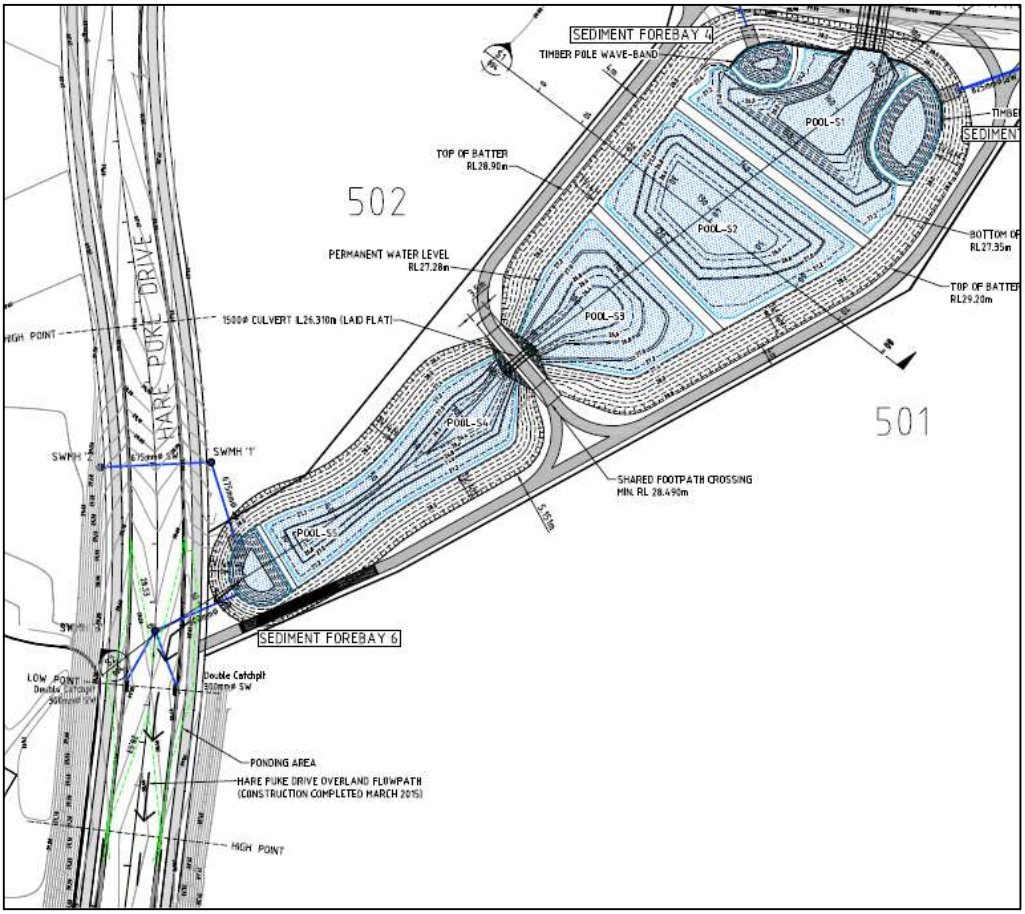


Figure 21 – Glaisdale Wetland (Otama-ngenge) overflow

A blocked outlet analysis was carried out to assess the worst-case spillway discharge and associated flood levels. Modelling was undertaken assuming the primary outlet pipe was fully blocked. The following initial water levels were modelled for the blocked outlet analysis:

- Live storage empty at the start of the storm event (WL at normal permanent water level = RL 27.28 m).
- Live storage full at start of storm event (WL at Hare Puke Drive overflow level = RL 28.53 m)

Table 3-5 which is an excerpt from the assessment report, presents the key results from the 24-hour nested storm incorporating Climate Change.

Table 3-5 – Glaisdale Overflow Assessment Results

Return Period (ARI)	Peak flow into wetland (m^3/s)	Peak outflow - Primary outlet (m^3/s)	Peak stage RL (m)	Peak Storage (m^3)	Overflow Peak Flow (m^3/s)
Normal Operation					
2	4.649	0.276	27.814	10,148	-
10	8.220	0.422	28.219	18,595	-
50	11.662	0.472	28.611	27,307	0.120
100	13.109	0.475	28.761	29,298	0.871
Primary Outlet Blocked Analysis					
100 – Live Storage Empty	13.109	-	28.761	20,787	2,090
100 – Live Storage Full	13.109	-	28.983	36,064	9.195

The Otama-ngenge ICMP states that allowance for the flow path must be reflected in roads under construction. Overland flow from the Glaisdale Wetland is protected by an easement. Two affected private properties have easements on their titles.

Refer to Figure 22 for the Glaisdale overland flow path location in relation to the Te Awa O Kātāpaki catchment.

The overland flow path should be modelled in more detail when the topography is finalised to verify the location and extent of overland flows. A conservative approach to setting freeboard and floor levels of remaining development bordering the flow path should be taken in the meantime. Although the predicted 100-year ARI overland flow is small at about 900 L/s and not likely to be deep it could still be classified as a flood hazard / risk if velocities are high enough and depth exceeds 100 mm.

The blocked outlet overflow approaches $10m^3/s$. Modelling of this scenario may be required but should be considered and agreed in relation to likelihood and the ability of the blockage to be observed and rectified before such as substantial overflow condition would be realised.

3.10.6 Tuirangi Floodway

Modelling shows that in a 100-year event in the future the Tuirangi Floodway is fully utilised. Capacity in the floodway will be maintained through:

- The Bourn Brook swale and associated upstream wetlands will provide the required water quality treatment and attenuation that the weir was originally proposed to achieve, except for the areas stated in the next bullet point.
- On-lot or centralised treatment and attenuation shall be provided for development sub-catchments not serviced by the Bourn Brook swale e.g. Resolution Drive and Rototuna Town Centre development sub-catchments (refer to Plan 012 in Appendix C, and Appendix F).

3.10.7 Upper Western Catchments and the Bourn Brook swale

The Bourn Brook swale was planned and designed generally in-line with the original concepts envisaged by HCC, the Rototuna Structure Plan and the 2006 Te Awa O Kātāpaki Catchment Management Plan. The swale extends through the 'Upper Catchment West' sub-catchment (refer to Plan 003).

The Bourn Brook swale was sized to attenuate peak 2-year and 10-year ARI storm flows from the 'Upper Catchment West' development area back to greenfield rates. The swale was originally intended to provide treatment for the 'Upper Catchment West' development area, however as constructed it does not provide treatment for this catchment.

The swale was designed to service flood flow from 'Upper Catchment West', the Waikato Expressway, and the 'Expressway West' sub-catchments. The swale has been sized to contain and convey unattenuated storm flows up to and including a 100-year ARI event with climate change. All stormwater runoff can be contained within the swale so overland flow across roads should only occur in the event of culvert or pipe blockage.

The swale also provides significant attenuation for events greater than the 2-year event as a by-product of its design. The 2/10-year discharge control structures (for attenuation) and the flood conveyance volume results in attenuation of events larger than 10-year ARI. The effect of the attenuation of larger events has not been formally quantified but it means that modelled downstream flood levels could be conservative.

The Bourn Brook swale operates in conjunction with a number of other drainage elements as follows:

a) The 'Expressway West' and 'Expressway' sub-catchments upstream of the swale require their own treatment and attenuation devices (drainage elements W4 and W1 on Plan 012). Both sub-catchments will discharge via the swale.
b) Runoff from the 'Upper Catchment West' sub-catchment is attenuated within the Bourn Brook swale (drainage element 14 on Plan 012).
c) Discharges from the swale will be conveyed through the 'Rototuna Town Centre' sub-catchment within the existing waterway to Borman Road (drainage element 12 on Plan 012). The existing watercourse has been assessed as a modified watercourse (defined by the NES-FM) and should be protected, enhanced and restored as a watercourse[25]. The Town Centre sub-catchment requires separate treatment and attenuation (drainage element W2 on Plan 012).
d) The central road through the Town Centre has been set below surrounding ground to facilitate its use as an overland flow path from North City Road in the event the North City Road culvert becomes blocked.

[25] Waikato Regional Council are considering this matter on a current resource consent application.

3.10.8 Defined overland flow paths

Significant defined overland flow paths, in addition to engineered channels, are shown in Figure 22 and include overland flow:

- From Glaisdale Wetland to the Te Awa O Kātāpaki Stream
- From the Resolution Drive catchment along Cumberland Drive to the Trinidad Tributary.
- From the upper east catchment to Borman Road (i.e. through Kirkdale Catchment).
- From Borman Road through to the Te Awa O Katapaki Stream.
- From the Bourne Brook Swale through to the Borman Road culverts.

Table 3-6 – Summary of key OLFPs and recommendations for capital funding provisions.

OLFP	Status	Description	Funding Recommended in 2024-34 LTP?
Glaisdale to Te Awa O Kātāpaki Stream	Constructed	Constructed as part of the Glaisdale sub-division. This OLFP is initially aligned along Hare Puke Drive. Approximately 150m downstream of the wetland the OLFP is diverted into an open channel swale before it crosses Cumberland Drive prior to discharging into the Te Awa O Kātāpaki.	N/A
Cumberland Drive	Constructed	Constructed as part of the Tenille sub-division. The OLFP runs south from the Tenille sub-division through undeveloped land prior to discharging onto the Cumberland Drive roading corridor at the intersection with Borman Road. The OLFP discharges into the Te Awa O Kātāpaki Stream opposite Sylvester Crescent.	N/A
Upper East	Proposed	OLFP connection required between the WEX and Borman Road. Future sub-division will be required to allow for flows passing through the site, however an upsize allowance has been recommended to ensure that full upstream catchment MPD flows are allowed for.	Yes
Borman Road to Te Awa O Kātāpaki Stream	Proposed	A connecting OLFP is required from Borman Road north to Rototuna Town Centre open watercourse via Turakina Rise. Currently, flows beyond the capacity of the Borman Road pipeline discharge south into residential areas. Formalisation of the OLFP will require Council-led works to modify levels along Borman Road to ensure flow is directed towards Turakina Rise and associated verge.	Yes

		Developer-led works will be required to provide a flowpath between Turakina Rise and the Te Awa O Kātāpaki Stream.	
Downstream of Bourne Brook Swale	Proposed	The suitability of the existing modified channel between the Bourne Brook Swale and the Te Awa O Kātāpaki Stream for conveyance of growth flows is unknown. Channel needs upgrades to add resilience and provide wider benefits of ecological enhancement through meanders and planting. Upsize funding has been proposed to achieve this.	Yes

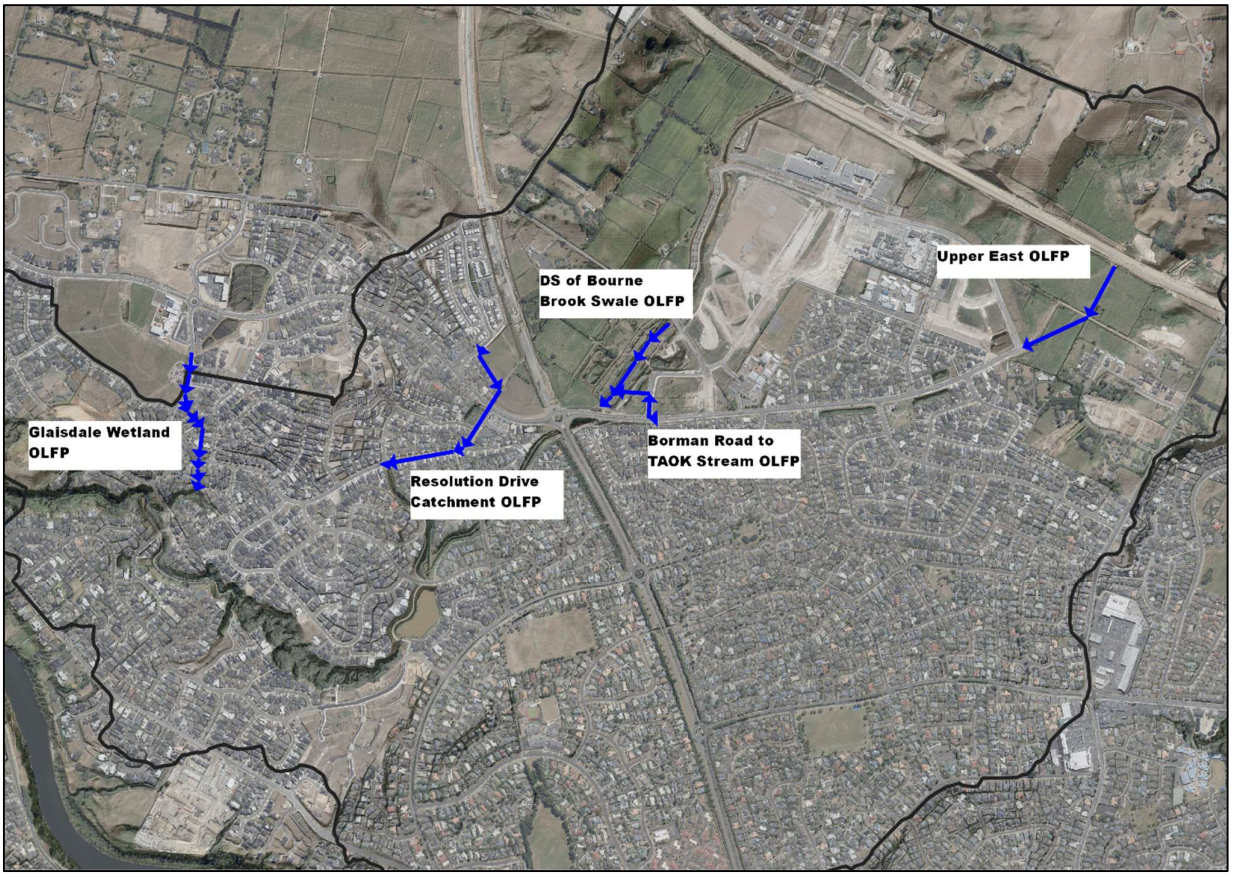


Figure 22 – Key overland flow paths

Specific data and maps such as all existing OLFP, OLFP direction, extent, mitigated and unmitigated OLFP, intersecting properties, OLFP catchment boundaries, and verification has not been generated for this ICMP. However, the key overland flow paths listed above have been mapped and where the OLFP has not yet been constructed capital works funding has been allocated to ensure correct outcomes are achieved.

3.11 Erosion and Scour – River North

At the time of this ICMP, River north (southern end of catchment) and River north (central catchment) has been consented. A detailed ecological assessment of River North was not completed due to issues with gaining access. The following will need to be considered when issuing resource consents in this catchment:

- Width/depth/angle/height/substrate/floodplain connectivity/scars/upper bank stability
- Location and extent of bank and channel modifications
- Location and extent of bank erosion/scour (and including outfalls/structures)
- Riparian condition assessment (Overhead cover, Riparian longitudinal and latitudinal extent, Vegetation type)
- Enhancement opportunities

3.12 Stormwater Quality

3.12.1 City Wide Monitoring

Council undertakes weekly visual monitoring under the Comprehensive Stormwater Discharge consent. The visual inspections identify floatable material (litter/rubbish), hydrocarbons, suspended solids, algae, Iron Floc and any other observations (including odour). The Te Awa o Kātāpaki forms part of this weekly monitoring regime. The figure below shows locations in the lower catchment that are inspected weekly (red circle).

Figure 23 – Visual weekly water monitoring locations on the Te Awa o Kātāpaki lower reach

3.12.2 Comprehensive Stormwater Discharge Consent Baseline

The HCC CDSC references a baseline from the report titled *NIWA, Hamilton City Stormwater, Assessment of Contaminant Loads and Impacts on the Waikato River, 2000*. This study involved composite sampling of 4 outfalls representing different land uses in the city (to analyse loads from each) and then analysis of total load. This study was repeated in 2015[26]. The results are below:

[26] Comprehensive Stormwater discharge consent 105279, 2015/16 Monitoring Report, Tonkin & Taylor, September 2017

Table 6.13: Comparison of annual contaminant loads (units in tonnes) discharging into the Waikato River. Contaminant load units in tonnes/yr. Bacteria load units in cfu/yr.

Parameter	Williamson 1999	1999/00 study	2015/16 study
TSS	3525	2020	1084
TN	75	26	31
TP	7.5	6.3	2
Cu	0.85	0.35	0.16
Pb	1.9	0.3	0.03
Zn	7	7.2	8
COD	-	-	1054
BOD	188	127	132
TPH	-	8.7	11.8 [1]
PAH	0.047	0.003	0.003
E. coli	-	1.30E+15	2.97E+15
Faecal Coliform	-	1.50E+15	-

1 – TPH loads are higher compared to the 1999/00 results due to the higher laboratory reporting limit used in the 2015/16 analysis.

Figure 24 – Excerpt from NIWA 2015/2016 – Annual Contaminant Loads

Table 6.14: Comparison of percentage increase of annual load into Waikato River

Parameter	1999/00 study				2015/16 study			
	Waikato River concentration	Waikato River mass load [1]	City-wide mass load	% increase	Waikato River concentration	Waikato River mass load [2]	City-wide mass load	% increase
	g/m³	tonnes	tonnes	%	g/m³	tonnes	tonnes	%
TSS	6	51088	2020	4	6	42006	1084	2.6
TN	0.16	1362	26	1.9	**0.434**	3038	31	1.0
TP	0.035	298	6.3	2.1	**0.029**	203	2	1.1
Cu	0.002	17	0.35	2.1	0.002	14	0.16	1.1
Pb	0.0002	2	0.3	18	0.0002	1.4	0.03	2.2
Zn	0.004	34	7.2	21	0.004	28	8	29.5
COD	-	-	-	-	-	-	1054	-
BOD	1.4	11921	127	1.1	**1.1**	7701	132	1.9
TPH	-	-	8.7	-	-	-	11.8	-
PAH	0.00012	1	0.003	0.3	0.00012	0.8	0.003	0.4
E. Coli	77	6.56E+15	1.30E+15	20	**81**	5.67E+15	2.97E+15	52.4
Faecal Coliform	160	1.36E+16	1.50E+15	11	-	-	-	-

1 – Waikato River mass load calculated from multiplying contaminant concentration and river flow. The flow is 270 m³/s (NIWA, 2001).
2 – Waikato River mass load calculated from multiplying contaminant concentration and river flow. The 10 year median flow is 222 m³/s, obtained from Appendix 1 of 2014 WRC report.
Bold – Concentrations obtained from WRC, 2014.

Figure 25 – Excerpt from NIWA 2015/2016 – Annual Contaminant Load Increases

Ignoring unavoidable differences in the methods applied, except for zinc and *E. coli,* the concentrations of contaminants in stormwater runoff are generally lower in the 2015 study compared to 1999/00. This is reflected in contaminant loads to the Waikato River, which (except for zinc and *E. coli*) are lower.

3.13 Contaminant Load Assessment

A contaminant load assessment (CLA) of Te Awa O Kātāpaki catchment was carried out May 2015 (AECOM)[27]. The contaminant inputs for residential land uses were based on the specific yields given in NIWA (2001), not modified to take account of the Brough et al. results for reduced metals concentrations from post-2000 subdivisions.

A preliminary contaminant load model was developed for the catchment to compare the 2000 baseline with the 2014 existing scenario and the predicted future development impacts. The loadings are derived from the Contaminant Load Model (CLM) developed by Auckland Regional Council (ARC). The CLM is a spreadsheet tool developed from the monitoring of contaminants in urban Auckland catchments.

The tool estimates the sediment, zinc, copper, and petroleum hydrocarbons (TPH) present in stormwater runoff based on land use. The tool enables assessment of various stormwater management options.

The CLM undertaken is based on likely treatments for the upper catchment stormwater. While the contaminant yields are only an estimate, they do allow a direct comparison between the existing and fully developed catchment.

Much of the catchment is either already developed or in the process of being developed (estimated at 70-80% developed as at August 2017). There are limited options to introduce significant measures to reduce contaminant loadings within the catchment. The CLM for the future scenario focuses on the following:

- Implementing Council's current strategy of using the proposed swale north of the Rototuna Town Centre to provide attenuation in the upper catchment.
- Implementing treatment for undeveloped sub-catchments that discharge to the Bourn Brook swale
- Consideration of the effect of additional at source treatment upstream of the wetlands (i.e. catchpit filters, rain gardens, wetlands)

A summary of CLM results are presented in the table below. Datasheets are provided in Appendix F.

Table 3-7 – Summary CLM Data for the Existing and Future (with mitigation) Scenarios

Scenario	Average Yields				Key Features
	TSS (kg/ha/ year)	Zinc (g/ha/ year)	Copper (g/ha/ year)	TPH (g/ha/ year)	
2000 Baseline	390	450	50	1430	Actual values from 2000 study (NIWA)
	391	450	98	1425	CLM model approximation of the 2000 baseline scenario
Existing (2014) Scenario	619	1047	206	3356	Existing stormwater features operational
Fully developed unmanaged	782	1918	395	6167	Existing stormwater features operational

[27] This has not been updated in line with new methodology as it is likely that, based on significant development already undertaken and BPO already determined, that solutions would not change.

					Development after 2014 uncontrolled
Developed managed – Option 1 **(preferred)**	622	1520	264	5888	Existing stormwater features well maintained Attenuation swale constructed north of Rototuna Town Centre and wetlands for all other sub-catchments constructed post 2014
Developed managed – Option 2	621	1512	264	5888	As per Option 1 with the addition of on-lot roof water re-use and rain gardens for hardstand
Developed managed – Option 3	617	1499	261	5761	As per Option 2 with the addition of road catchpit filters (refer RITS)
Developed managed – Option 4	606	1460	249	5253	As per Option 2 with the addition of road swales
Developed managed – Option 5	595	1382	232	4490	As per Option 2 with the addition of road rain gardens
Developed managed – Option 6	604	1450	247	5157	As per Option 2 with the addition of road swales and catchpit filters

Apart from Total Suspended Solids (TSS), an increase in contaminants of about 50% is expected with the continued development. The primary sources for these contaminants are summarised below in the table below.

An estimate of the proportion of managed and treated areas in the Te Awa O Kātāpaki and River North catchments has been carried the results of which are shown in Table 3-8. Managed areas include existing treated areas plus future development areas which will all be treated. The estimates do not allow for improvements because of redevelopment or retrofit.

Table 3-8 – Proportion of catchment serviced by treatment devices

Catchment	Area in HCC (Ha)	Anticipated managed area in HCC (Ha, ±10%)	% of catchment treated
Te Awa O Kātāpaki	744	540	72
River north	121	18	15

Table 3-9 – Primary sources of chemical contaminants in urban catchments

Chemical	Primary Source
Zinc	Vehicle tyres, galvanised building materials (e.g. roofs and fences), paints, industrial activities
Copper	Vehicle brake pads, plumbing, industrial activities, garden spray
Total Petroleum Hydrocarbon (TPH)	Domestic fires, industrial emissions, vehicle exhaust, vehicle lubricating oil

Pesticides	Gardening

The results of the CLM assessment indicate that:

- Use of the various means of compliance set out in Table 3-7 to treat stormwater will result in an approximate 50% increase in total contaminant loads of petroleum hydrocarbons, copper and zinc. This assumes that the devices perform as expected following development and are adequately maintained.
- The sediment load is expected to decrease slightly because of completion of earthworks and reduction in pasture area.
- When compared with metals concentrations in fully urbanised, partly urbanised, and rural Hamilton catchments, Te Awa O Kātāpaki metals concentrations can be expected to remain similar to existing concentrations and may decrease slightly as suspended sediment loads decrease.

For the existing and proposed land use, it is concluded that the primary contributor to increased contaminants within the catchment are vehicles and increased vehicle movements. Population growth and residential development are contributing factors in the absence of planned industrial development.

The reduction in TSS is opposite to the increase in other contaminants. Bulk earthworks and pasture are the primary contributors to sediment runoff. The existing model assumes significant earthworks within the catchment (in the order of 20 hectares), and the upper catchment is currently undeveloped. The predicted TSS runoff load can be maintained at the 2013 using wetlands in all sub-catchments designed to remove 75% TSS. The reason that this is possible at 75% removal is because bulk earthworks and pasture will not exist in the fully developed scenario.

RITS (or other equivalent document) will be the baseline in mitigation measures for future developments. Consistent with existing development within the catchment, the target reduction in TSS will be 75%. Additionally, devices will be able to remove other contaminants such as zinc, copper and TPH. Incorporating filtration, infiltration or wetland characteristics are the most efficient for removal of these contaminants.

4 Surface Water Quantity and Flooding

This Section relates only to the Te Awa O Kātāpaki Catchment. The River North Catchment has not been modelled because it falls directly to the Waikato River and flooding and overland flow is not generally an issue.

Key Update	Key Mitigation	Conclusion
1. **Stormwater modelling has been completed and the catchment reflects good urban design with flooding generally limited to designated drainage channels and road reserves as per accepted practice.**	1. Engagement with landowners regarding flood hazard GIS viewer and impact of modelled flooding in the catchment, flood data has been made publicly available	1. Flood levels will be contained largely within gully and stream network (except for minor flood extents, and below existing building platforms).

2. The modelled estimates are conservative and can be considered with any new development and can be applied to development of centralized stormwater attenuation devices in greenfield areas.	2. Centralised attenuation devices in greenfield areas will result in no more than minor effects of development on the existing flood hazard, with some devices requiring flood attenuation.	2. MPD 100yr flood + climate change in the catchment will result in no more than minor effects and will not exacerbate existing catchment flood hazard. Means of Compliance table is clear about which catchments require flood control.
3. Flood modelling results indicate a small number of properties may become impacted by flood hazard based on effects of climate change and conservative infill development assumptions.	3. Proposed flood attenuation, to the maximum reasonable extent in greenfield areas protects people and property from existing and future flood risk, accounting for the effects of climate change.	3. Flooding increase in brownfields is less than minor. 4. Flood management programme to address brownfield flooding issues approved as part of LTP.

4.1 Flood Modelling

Detailed flood hazard modelling was carried out in the Te Awa O Kātāpaki catchment over the period 2013-2015. The modelling consists of a detailed 1D/2D MIKEFLOOD model that covers the entire catchment. Additional modelling was undertaken in 2017 using an updated model which replaced large areas of the upper catchment with hydrologic routing. The purpose of the additional modelling was to assess the effects of flow attenuation on flooding along Borman Road.

Full details and plans of flooding within the catchment are presented in the following reports:

- Te Awa O Kātāpaki Integrated Catchment Management Plan – Model Build Report, August 2015 (Appendix K).
- BECA Review 1
- Te Awa O Kātāpaki – Flood Model Rerun for Higher Developed Impermeability, AECOM, 28 June 2017.
- TAOK Stormwater Model Report – Final Draft, Beca 2017 (Appendix L)
- TAOK Review of Consents, Flooding & OLFPs, Beca 2021 (Appendix M).

The final Beca memorandum (Beca, 2021) provides an overall summary of the model peer review process and outcomes, as the original model build report was not revised with subsequent scenarios and peer review outcomes.

4.2 Scenarios Modelled

Stormwater modelling to support the ICMP outcomes was originally completed in 2015 by AECOM. The modelling was based on LiDAR topographic data from 2008. In areas where landform or development changes took place since 2008, new data (earthworks) sourced from sub-division designs was incorporated into the model to represent land-form changes since LiDAR capture.

The peer review process determined that some of the MPD catchment changes made in the model meant that additional modelling scenarios were required to determine flood attenuation requirements. In 2017, a subsequent round of modelling was completed which focused on flood attenuation requirements in the upper eastern catchment and associated downstream flood impacts. The 2017 modelling was based on the same topographic sources, however it removed large parts of the upper catchment from the flood model which were replaced with hydrologically routed inflows. Upper catchment attenuation was modelled within the hydrologic model.

Due to the level of earthworks associated with sub-division development within the catchment through the period 2008 – present, much of the model results are not suitable for setting residential floor levels due to changes in landform (floodplain) shape. In consultation with the peer reviewer, the HCC flood information data levels have been applied to the model results.

4.3 Flooding Technical Assessment

Comparisons of existing (ED) and predicted future flood hazard extents (MPD mitigated) for the purposes of identifying effects were made primarily using the outputs from the final 2017 modelling scenarios. Results from the original 2015 model were used to inform assessment of the effects of climate change and infill in brownfield development areas as the 2017 modelling did not assess climate change for existing development.

Figure 26 shows a comparison of 100y ED (with climate change) and 100y MPD (mitigated, with climate change) flood extents. The ED results are sourced from the 2015 modelling results, while the MPD mitigated scenario modelling is from the 2017 model.

100y ARI flooding (flood hazard) within the existing urban areas of the TAOK catchment is generally confined to road reserves and the drainage network (including waterways). The highly confined nature if model outputs in Figure 26 demonstrates that the main TAOK channel consists of an incised gully system with a flow capacity greater than the 100y MPD (mitigated) flood flow.

The presented MPD results only incorporate flood attenuation measures in the upper eastern catchment area which drains to the Borman Road pipeline. In reality, flood attenuation will be provided for in both the eastern and western branches of the upper catchment. The upper eastern catchment will be attenuated in the Bourn Brook swale, which was not incorporated into the 2017 model scenario. Based on this, modelled peak flood flows in the main TAOK channel downstream of Resolution Drive will be conservative as they will be over-estimated because the Bourn Brook swale has not been accounted for.

A summary of key effects observations based on comparison of ED and MPD 100y flood outputs are as follows:

- Increases in 100y ARI flood extents are observed along all reaches of the main TAOK channel downstream of the Resolution Drive – Borman Road intersection. In all locations increased flood extents are confined to the main channel (gully) extent. The reach immediately upstream of the Petersburg bridge crossing was identified as being most critical in terms of potential impacts to private properties. This reach showed increases in flood extent on properties which back directly onto the TAOK stream, however increases do not affect buildings.

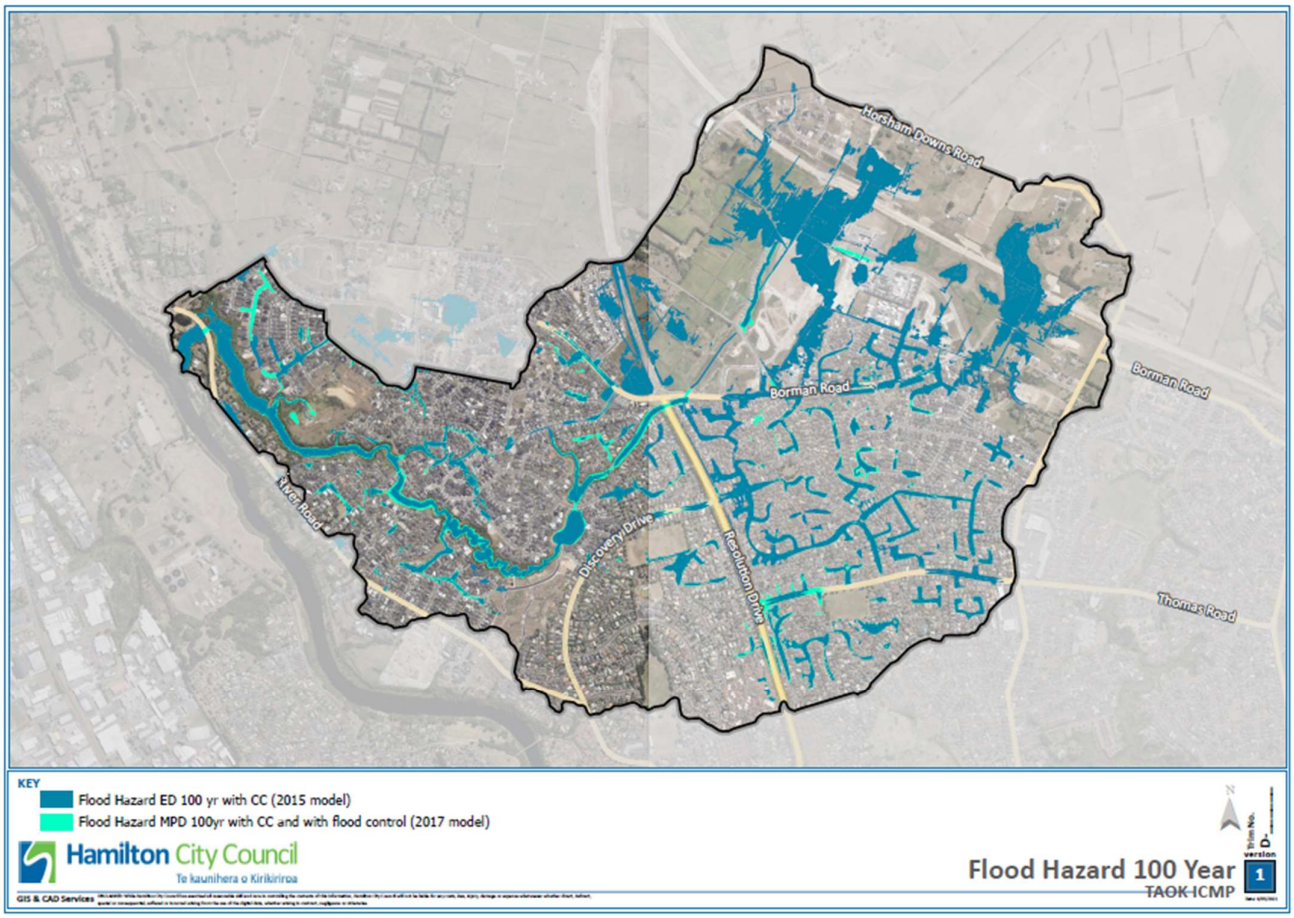
- A more in-depth analysis of predicted peak depths against LiDAR survey data was undertaken immediately upstream of the Petersburg Drive crossing on the main TAOK stream. Predicted peak 100y MPD flood depths are observed to be well below built floor levels in this location.
- Outside of the main stream area, increases in flood hazard extent are observed in a number of locations within the existing brownfield residential area in the mapped MPD scenario. Impacts in existing urban brownfield are expected as the MPD scenario assumes infill development will not be mitigated.
- Impacts on existing (brownfield) private properties due to infill development are focused around the Resolution Dive – Thomas Road roundabout. A large stormwater main (1800mm) which drains the local primary network runs below the roundabout with Resolution Drive forming a barrier to overland flow. Increased flows associated with infill development pond in this area due to blockage of secondary overland flows. In this vicinity Seven (7) dwellings have been identified as likely being impacted by a flood hazard in the MPD scenario in a less than minor manner, which were not impacted in the ED scenario.

The results of the flood modelling indicate that the with the proposed flood attenuation measures in-place no additional private properties along the main TAOK stream will impacted by flooding due to MPD development measures in a 100y event within the TAOK catchment.

Flood modelling results indicate that a small number of properties within existing brownfield areas may become impacted by flood hazard based on the infill development assumptions used in the modelling. These impacts are due to increased impervious assumptions used for the MPD scenario. Brownfield flood impacts are predicted to be focused upstream of Resolution Drive and Thomas Road in Rototuna North.

No conceptual mitigation measures are proposed for the Resolution Drive/Thomas Road as it is considered unlikely that MPD catchment conditions will actually reflect the conservative assumptions used in the modelling assessment.

Figure 26 - Comparison of 100y ARI ED and MPD flood hazard extent (100mm depth removed from extent)


Horsham Downs Road
Borman Road
Borman Road
Thomas Road
River Road
Discovery Drive
Resolution Drive
KEY
Flood Hazard ED 100 yr with CC (2015 model)
Flood Hazard MPD 100yr with CC and with flood control (2017 model)
Hamilton City Council
Te kaunihera o Kirikiriroa
GIS & CAD Services
Flood Hazard 100 Year
TAOK ICMP
Plan No.
Version
1

4.4 Key Outcomes and System Performance

a) The primary drainage network operates adequately in all but the largest events. Overland flow occurs only in extreme cases above the intended network level of service except for several areas of minor ponding in roads in smaller events. In all developed areas, flooding is generally limited to designated drainage channels and road reserves as per accepted practice.

b) Several property parcels showed some flooding from the main watercourse in a 100-year ARI event (with climate change) in the lower part of the catchment near St Petersburg Drive. Further assessment showed that showed that property floor levels are above the predicted flood level.

c) Several property parcels showed an increase in flooding in the 100y MPD scenario in the vicinity of the intersection of Thomas Road and Resolution Drive. Seven (7) building footprints are predicted to be impacted by some level of flood hazard. These impacts are the result of unmitigated infill development assumptions.

d) Survey and mapping shows that large event attenuation will have a significant positive effect in reducing predicted flooding along Borman Road east which is indicated to extend into properties. Attenuation of the 100-year ARI event is therefore required in the east of the upper catchment to manage effects on Borman Road as far as practical.

e) Surface ponding in greenfield areas that are not yet developed is expected. Once development occurs, ponding will be limited by the design of the primary drainage network and overland flow paths via new road corridors as per the requirement of the RITS.

The performance of the key major system components for the 100-year ARI (1 % AEP) event at maximum development (including attenuation measures) are as follows:

- Borman Road Culvert – flows are contained within the upstream and downstream channels and no flow is predicted to occur over the road.
- Resolution Drive Culvert – flows are contained within the upstream and downstream channels and no flow is predicted to occur over the road.
- Tuirangi Floodway – flows are contained within the channel.
- Magellan Rise Culvert (upstream of Magellan Lake) – flows are contained within the upstream channel and no flow is predicted to occur over the road.
- Magellan Lake and outlet – The predicted lake level does not extend past the limits of the lake and the associated drainage reserve. Lake discharges appear to be controlled adequately and outlet velocities increase a small amount as development occurs and peak flow increases.
- St Petersburg Culvert / Bridge – This location is inundated in the 100-year event by design. The modeled flooding is consistent with the intent of the design and alternative access is present using other roads.
- River Road Culvert - flows are contained within the upstream channels and no flow is predicted to occur over the road. Flooding at the outlet can extend into the Horsham Downs golf course and is predicted in both the undeveloped and developed scenarios.

Opportunities to reduce flood levels in the lower sub-catchments, through measures in the upper catchment, are now limited. There does not appear to be any areas that definitively require further investigation to eliminate high risk flooding of property and habitable buildings.

Low to medium hazard flooding is predicted on private property in some areas; typically, shallow overland flow or ponding on property frontages associated with road overland flow paths or ponding. Further assessment of property boundaries and infrastructure (such as fences or gardens) that may contribute to property-scale overland flow will be undertaken through the city-wide OLFP programme proposed.

Refer to AEE Section 13.3 for additional discussion of flooding effects.

5 Consultation

5.1 Description of Consultation Programme

A Consultation and Communications Plan (CCP) has been prepared. The purpose of the CCP is to identify the key stakeholders and landowners with whom consultation is recommended. Consultation and communication will be undertaken in accordance with the CCP and will comprise the following:

- Discussions within HCC regarding the catchment area, existing system, and constraints
- Discussions with WRC regarding existing knowledge about the receiving waters
- Circulation of an interim ICMP
- Letters to the landowners and stakeholders informing them of the ICMP, and inviting their comments
- Follow up meetings with landowners in response to the initial letters

5.2 Stakeholders Identified

The following parties will be consulted and communicated with in accordance with the recommendations of the CCP.

- The owners, occupiers, and development consultants of land within the catchment with a device on their property (affected parties)
- Stream Care Groups (as advocates for natural resources)
- Waikato Tainui (in accordance with the Waikato River Settlement Act)
- Ngaati Wairere (mana whenua)
- Te Haa o Te Whenua o Kirikiriroa (THaWK)
- Waikato Regional Council (as manager of river catchments and as the regional authority)
- Department of Conservation (as advocates for conservation of natural and historic resources)
- Hamilton City Council internal units (as executors of the ICMP)
- Waikato District Health Board (as advocates for public health)
- Centre for Biodiversity and Ecology Research, University of Waikato (as advocates for biodiversity and natural resources)
- North East Community Hub (as local advocates for social and environmental wellbeing)

It is important to note that Waikato Tainui (represented by Te Whakakitenga o Waikato) is the Waikato River co-manager.

6 Operational Objectives

Operational objectives address key infrastructure and asset operation issues for HCC's three waters networks and align with Strategic objectives. Any conflict between developmental yield targets permitted by the District Plan must both meet operational, regulatory, and environmental requirements.

6.1 Operational Issues

6.1.1 Stormwater

Issue 1 – Erosion and instability

Erosion exists in the downstream section of Te Awa O Kātāpaki Stream. Assessments indicate that further erosion could occur where vegetation is cleared from steep slopes. Instability could occur where surface or ground water exits the top of steep gully slopes.

Erosion and instability are most relevant in the gully downstream of Magellan Lake because it is close to its original state. In the upper catchment the Tuirangi Floodway is stable and constructed swales may erode until planting fully establishes.

Hydraulic modelling indicates that runoff volumes and flow velocities will increase with development. To minimise the risk of erosion and instability, extended detention, volume control and area specific attenuation up to the 10-year event is required in conjunction with efforts to reduce discharges (i.e. soakage and water re-use). River north watercourses have not been able to be properly assessed.

Issue 2 – Contamination from development

Construction activities are affecting suspended sediment levels in the stream. Although treated construction discharges are minor in isolation, the cumulative effect of multiple large-scale developments is evident. It is important that sediment control enforcement is applied in the developing catchments by WRC and HCC.

It is evident that runoff from existing development is affecting water quality in the stream. Once the balance of the catchment is developed, this will correspondingly increase unless treated.

Issue 3 – Contamination from poor treatment

The Te Awa O Kātāpaki stream has similar water quality characteristics to other Hamilton waterways and CBOD and petroleum hydrocarbons are below the detection limits. ANZECC guideline values are exceeded for faecal coliforms, metals, and nutrients. MCI and SCMCI scores reflect the longer-term influence of ongoing poor water quality including elevated turbidity, temperature, and dissolved metals concentrations and low dissolved oxygen.

Average suspended sediment and turbidity is almost three times greater in Te Awa O Kātāpaki than in other Hamilton catchments (note other catchment are not being developed to the same extent). Faecal coliforms exceed Ministry for the Environment guidelines for human contact, and the median for Hamilton rural streams (500 cfu per 100 ml). Plant could uptake metals which may be an issue for potential

watercress harvesting. Thermal storage in open water bodies can also be an issue for dissolved oxygen levels and aquatic health.

Issue 4 – Gully and stream system modification
The lower gully system downstream of Magellan Lake is one of the more intact gullies in Hamilton. The physical gully environment is largely unmodified by development but is degraded in terms of habitat due to discharges from farms and urban development. If the lower system were to be modified in the same manner as the upper system has been, the habitat will be lost.

Issue 5 – Potential flooding
Runoff will eventually increase from areas still to be developed. If the runoff is not directed to specific overland flow paths and flood areas, persons or property could be at risk. Existing developments in the downstream catchment have adequately dealt with this issue based on modelled outputs. Undeveloped parts of the upper catchment will require overland flow paths and flow controls (attenuation) to be designed and implemented.

Issue 6 – Amenity, and nuisance and safety
Shallow densely planted wetlands are the preferred solution where a large treatment and detention device is proposed. Wetlands provide enhanced treatment and habitat while minimizing potential safety and stagnant issues associated with large areas of standing water.

Careful plant selection and wetland design should still be undertaken to manage residence time of water during dry periods. Plant health is also linked to water availability and in some cases can require frequent replacement and maintenance. There will be cases where, for example, a dry detention area may be more suitable than a large permanent wetland for attenuation.

Issue 7 – General network level of service
Nuisance flooding that would affect persons or property is generally not a high-risk issue in the Te Awa O Kātāpaki Catchment. A small number of road areas are predicted to have minor low hazard flooding in a 2-year ARI event when the primary piped network should otherwise cater for stormwater runoff without flooding.

At this stage, no network improvement projects have been proposed for the existing stormwater network in the Te Awa O Katapaki catchment.

6.1.2 Wastewater

Issue 8 – Inflow and infiltration
The existing wastewater network will service development in the northern catchment. The network is not expected to have problems as a result of new development discharges. A degree of inflow and infiltration is expected and included in modelled predictions.

Best practice design, construction and inspection are required to ensure that potential I&I is minimised. This will reduce operational costs in the network and the plant and maintain the service capacity of the local network.

Issue 9 – Existing septic tanks

Some existing large lots (>2500 m^2) are serviced by septic tanks and will require a public wastewater system to be installed should subdivision occur and the minimum lot size requirement for on-site wastewater disposal is not met.

6.1.3 Water

Issue 10 - Water demand

Increased water demand is not expected to affect local infrastructure. Increased demand will affect the treatment plant and the raw water source as the city grows. Efficient water use, including re-use where possible, will be an important tool to reduce water demand in accordance with the ODP. At this point in time there are no requirements to go beyond the ODP requirements.

6.1.4 Asset Management of Water and Wastewater Networks

Issue 11 – Poor maintenance of on-lot devices

The effect of maintenance, or lack thereof, of on-lot devices on the receiving network, environment or public health is a key issue. Currently Bylaws are the mechanisms for requiring maintenance. The use of Consent Notices is being considered to ensure property owners understand responsibilities for maintenance and improved data capture systems on type and location of on lot systems is being developed so catchment loads can be better assessed, and device auditing carried out.

Issue 12 – Optimisation of existing assets

Hamilton City Council's water and wastewater strategies are the overarching plan for the development of major water infrastructure. The strategies seek to promote good asset management through the following:

- Minimise the number of water supply reservoirs
- Minimise the number of booster pump installations
- Manage water supply zones to balance pressure, leakage, and demand requirements
- Minimise the number of wastewater pump stations or eliminate existing pump stations
- Manage the growth of the wastewater network to optimise the use of existing infrastructure and avoid costly upgrades (i.e. utlising wet weather storage as opposed to extensive conveyance upgrades)

Developers must incorporate planned major infrastructure by working with HCC to identify what is required within their development. Outside of major infrastructure required to service the wider catchment, developers will need to minimise the number of pump stations and reservoirs.

Issue 13 – Inconsistent network solutions and devices

Collection and distribution networks should generally match the existing city network in order to maximise commonality and efficient maintenance (i.e. conventional gravity sewers). This does not preclude the use of alternative technologies (i.e. low pressure sealed sewer systems) but means that they will need to be proven more practical and cost effective.

It is expected that alternative systems would only become practical or acceptable on a catchment wide basis. The application of alternatives on a small scale or for discrete developments is unlikely to be approved unless there is no other viable solution.

Issue 14 - Maintenance of proposed devices
Devices must be easy to maintain. Access and traffic management requirements should factor into device selection in conjunction with the nature and frequency of routine maintenance.

6.2 Operational objectives

The following Operational Objectives must be considered for future development activities.

Operational Objective 1 - Protect stream water and sediment quality

Operational Objective 1 can be met by the following:

a. Where site and soil conditions allow, stormwater shall be discharged directly to ground via soakage (following appropriate treatment). This will minimise increases in discharge volume and replenish groundwater. Soakage also is an effective method of removing contaminants from entering the environment, as long as appropriate treatment is provided before soakage. If treatment is not provided, there is the potential for contaminants to build up in existing soils and potentially migrate into groundwater.

b. Primary stormwater discharges shall be treated to a high level prior to discharge. The system is to achieve at least 75% sediment removal for the catchment. Contaminants derived from urban or road stormwater are managed through appropriately designed treatment devices, so that any increase in mass contaminant loads and concentrations in the receiving environment following development, are minimised as much as practicable. Hazardous substances from Commercial properties shall be prevented from entering the stormwater network via suitable interception devices.

c. Stormwater quantity will be managed to avoid erosion and scour effects in the receiving environment, by providing extended detention and volume control, and peak flow attenuation where necessary.

d. For general guidance purposes the following guidelines (or updates thereof) are referred:

   i. For instream water quality and comparison with baseline contaminant concentrations: ANZECC, 2000 – 'Australian and New Zealand Guidelines for Fresh and Marine Water Quality'

   ii. For instream sediment quality and comparison with baseline contaminant concentrations: ANZECC, 2000 – 'Australian and New Zealand Guidelines for Fresh and Marine Water Quality / Interim Sediment Quality Guidelines (ISQG)'

   iii. For treatment device design and performance efficiencies: Waikato stormwater management guideline (TR2020/07), Regional Infrastructure Technical Specification.

e. Devices servicing roading shall be suitable for the removal of hydrocarbons.

f. Construction generated sediment shall be controlled to meet Waikato Regional Council standards and shall comply with relevant city bylaws and District Plan requirements.

g. Where it is shown that a single device will not address receiving environment sensitivities, that a treatment train approach should be adopted and to minimise temperature effects and maximise contaminant removal.

h. Water, wastewater and stormwater systems are to be designed for ease of access to monitor, maintain, repair and replace.

Links to:

- Strategic Objective 1, Environment, Cultural, Social
- Issue 2

Operational Objective 2 - Mass loads and concentrations of stormwater contaminants are progressively decreased

Operational Objective 2 can be met by the following:

a. Dense riparian and/or wetland/aquatic vegetation cover must be established and maintained on all new surface stormwater systems (swales, flood ways, wetlands) within a maximum of 3 months of construction. Planting must consist of indigenous eco-sourced plant species appropriate to the lowland Waikato location.

b. Avoid construction of new on-line open water devices.

c. Require existing open water devices to achieve >80 % cover of wetland and/or riparian vegetation to maintain cool downstream temperatures if required to meet ongoing performance requirements. This may require alternative water level management or bathymetry changes to facilitate aquatic macrophyte and riparian vegetation establishment.

d. Undertake monitoring to confirm device performance and detect changes in contaminant profile and temperature over time.

e. Strengthen erosion and sediment control effectiveness during and immediately post construction.

Links to:

- Strategic Objective 1, Environment, Cultural, Social
- Issue 2

Operational Objective 3 - Habitat quality in on-line devices (wetlands, swales, lakes, and ponds) accommodates native fish populations

Operational Objective 3 can be met by the following:

a. Dense riparian and/or wetland/aquatic vegetation cover must be established and maintained on all new surface stormwater systems (swales, flood ways, wetlands) within a maximum of 3 months of construction. Planting must consist of indigenous eco-sourced plant species appropriate to the lowland Waikato location.

b. Require existing open water devices to achieve >80 % cover of wetland and/or riparian vegetation to maintain cool downstream temperatures if required to meet ongoing performance requirements. This may require alternative water level management or bathymetry changes to facilitate aquatic macrophyte and riparian vegetation establishment.

c. Avoid new weir structures and monitoring existing weir structures to confirm whether these present a barrier to fish passage and improve them if they are.

Links to:

- Strategic Objective 1, Environment, Cultural, Social
- Issue 4

Operational Objective 4 - Native fish population diversity and distribution are enhanced in the Te Awa O Kātāpaki Stream.

Operational Objective 4 can be met by the following:

a. Dense riparian and/or wetland/aquatic vegetation cover must be established and maintained on all new surface stormwater systems (swales, flood ways, wetlands) within a maximum of 3 months of construction. Planting must consist of indigenous eco-sourced plant species appropriate to the lowland Waikato location.

b. Avoid construction of new on-line open water devices.

c. Require existing open water devices to achieve >80 % cover of wetland and/or riparian vegetation to maintain cool downstream temperatures if required to meet ongoing performance requirements. This may require alternative water level management or bathymetry changes to facilitate aquatic macrophyte and riparian vegetation establishment.

d. Green engineering solutions used to stabilise stream banks between Lake Magellan and Petersburg Drive to facilitate low stature riparian planting.

e. Encourage and coordinate with Waikato Regional Council consent processing officers and compliance officers to strengthen erosion and sediment control effectiveness during and immediately post construction.

f. Avoid new weir structures and monitoring existing weir structures to confirm whether these present a barrier to fish passage and improve them if they are.

Links to:

- Strategic Objective 1, Environment, Cultural, Social
- Issue 4

Operational Objective 5 – Minimise alterations to the natural flow regime

Operational Objective 5 can be met by the following:

a. Where site and soil conditions allow, stormwater shall be discharged directly to ground via soakage. This will minimise direct discharges to the stream, help to recharge groundwater, maintain stream base flows, and mimic the natural water cycle.

b. Where discharge to the stream needs to occur, extended detention and volume control shall be provided in accordance with the RITS and TR2020/07. This will control flow velocities and erosion.

c. Energy dissipation and erosion protection measures are provided at all discharge locations, and preference is given to green engineering solutions over hard engineering solutions based on rock and concrete.

d. Natural state areas, such as freshwater springs, shall remain undisturbed and shall not receive developed discharges.

e. Peak flow management is required for small events, and pre-development flow shall be maintained for up to the 2-year and 10-year ARI storm events in the upper catchments.

Links to:

- Strategic Objective 1, Environment, Cultural, Social
- Issue 1

- Operational Objective 6

Operational Objective 6 – Avoid and reduce instability, erosion, and scour of the Te Awa O Kātāpaki Stream downstream of Lake Magellan, and in recently established and new swales

a. Dense riparian and/or wetland/aquatic vegetation cover must be established and maintained on all new surface stormwater systems (swales, floodways, wetlands) within 3 months of construction. Planting must consist of indigenous eco-sourced plant species appropriate to the lowland Waikato location.

b. Green engineering solutions used to stabilise stream banks between Lake Magellan and Petersburg Drive to facilitate low stature riparian planting.

c. Plant indigenous eco-sourced riparian and/or wetland/aquatic plant species with rhizome root systems and low stature appropriate to the lowland Waikato location to enhance bank stability while maintaining public safety along public paths

Links to:

- Strategic Objective 1, Environment, Cultural, Social
- Strategic Objective 3, Environment
- Issue 1
- Operational Objective 5

Operational Objective 7 – Utilise water sensitive practices

Operational Objective 7 can be met by the following:

a. Where site and soil conditions allow, stormwater shall be discharged directly to ground via soakage. This will minimise increases in discharge volume, help to recharge groundwater, maintain stream base flows, and mimic the natural water cycle.

b. The use of 'water sensitive practices 'shall be incorporated into the stormwater management approach for the catchment. Refer to Section 11 for BMPs and Section 12.3 for means of compliance.

c. Where it is shown that a single device will not address flood risk or receiving environment sensitivities a treatment train approach shall be adopted.

Links to:

- Strategic Objective 4, Environment, Economic
- Issue 1, 5, 8, 11, 13

Operational Objective 8 – Protect and enhance gullies and watercourses

Operational Objective 8 can be met by the following:

a. Riparian vegetation density and cover is established, maintained and/or enhanced on all waterways, including stormwater swales to maintain habitat, bank stability and water quality (temperature and dissolved oxygen).

b. Existing riparian vegetation in gully reserve areas shall be protected.

c. Gully restoration and further riparian planting shall be encouraged in conjunction with developers, the local stream care group, local iwi and other interested parties.

d. Avoid the direct discharge of water at the top of gully slopes, either to ground or soakage, in a manner which could affect the stability of gully slopes.

e. Undertake in-stream erosion and control works only where people or property is at risk. Undertake such works using natural solutions which will enhance habitat and maintain natural stream processes.

f. Dense riparian and/or wetland/aquatic vegetation cover must be established and maintained on all new surface stormwater systems (swales, floodways, wetlands) within 3 months of construction. Planting must consist of indigenous eco-sourced plant species appropriate to the lowland Waikato location, with a high proportion of rhizomatous species.

g. Green engineering solutions used to stabilise stream banks between Lake Magellan and Petersburg Drive to facilitate low stature riparian planting.

Links to:
- Strategic Objective 2, Environment, Social
- Issue 1

Operational Objective 9 – Have due regard for centralised three waters management and economic affordability

Operational Objective 9 can be met by the following:

a. Proposed stormwater management systems are to be cost-efficient during long term operation and maintenance.

b. Proposed new three waters assets are to be justified - the use of existing assets before creating new assets is preferred to reduce long term operation and maintenance.

c. Proposed new assets that have operational and maintenance needs inconsistent with other assets must have proven benefit.

d. Plan and implement three waters networks on a catchment wide basis to minimise the number of stormwater treatment devices, wastewater pump stations and storage devices (unless individual on-lot).

e. Integrate three waters networks within the catchment prior to discharge to the wider city networks.

Links to:
- Strategic Objective 7, Strategic Objective 10, Economic
- Issue 7, 8, 11, 13, 14, 15

Operational Objective 10 – Protect cultural values

Operational Objective 10 can be met by the following:

a. Where site and soil conditions allow, stormwater shall be discharged directly to ground via soakage. If soakage is not viable, discharges to surface water shall be treated.

b. The use of water sensitive practices shall be incorporated into the stormwater management approach for the catchment.

c. Appropriate public access to the gully system shall be provided.

d. Existing riparian vegetation in gullies shall be protected by inclusion in gully reserve areas as defined in the operative structure plan.

e. Gully restoration and further riparian planting shall be encouraged in conjunction with developers, the local stream care group, local iwi and other interested parties.

f. Except for existing structures, or proposed structures identified in this ICMP, no structures, including stormwater management systems, are to be located within existing streams.

Links to:

- Strategic Objective 2, Strategic Objective 6, Cultural

Operational Objective 11 - Maintain or improve flood protection level of service

Operational Objective 11 can be met by the following:

a. The Te Awa O Kātāpaki Stream, Tuirangi Floodway and the Bourn Brook swale are sufficient to convey the 100 year storm event at maximum development.

b. Overland flow paths shall be provided to safely direct all runoff to the stream network in accordance with HCC standards. Wherever possible, the use of private property for overland flow paths shall be avoided.

c. Sufficient freeboard protection, in accordance with HCC standards, shall be provided to building floor levels.

Links to:

- Strategic Objective 5, Social
- Issue 5

Operational Objective 12 – Public safety designed and monitored

Operational Objective 12 can be met by the following:

a. Water, wastewater and stormwater systems are to be designed for public safety.

b. Undertake regular sediment quality monitoring at sites with accessible watercress to determine whether metals concentrations are increasing. If metals concentrations increase, consider monitoring of plant material to define the level of public risk.

Links to:

- Social
- Issue 6, 15

Operational Objective 13 – Minimise water consumption and wastewater discharge

Operational Objective 13 can be met by the following:

a. Incorporate water efficient fittings into homes and promote sustainable water use practices.

b. Collect and store stormwater for non-potable use or discharge to land (such as toilet flushing, clothes washing, car washing and watering gardens).

c. Minimise the volume of water taken and treated by promoting sustainable water use.

d. Avoid or minimise future infrastructure upgrades by identifying and managing inefficiencies such as leakage, inflow and infiltration and unauthorised use.

Links to:

- Strategic Objective 7, Strategic Objective 8, Strategic Objective 10, Strategic Objective 11, Environment, Economic
- Issue 7, 8, 11

6.3 Integrated Three Waters Objectives and Opportunities

The District Plan provides a range of water sensitive techniques to minimise the impact of development and enhance the environment. District Plan rules and requirements must be understood and followed.

Much of the catchment is either developed or consented for development therefore there is limited opportunity to mandate some specific solutions in those areas. Notwithstanding, future initiatives should focus on water re-use as opposed to network upgrades.

For greenfield areas yet to be consented, the opportunity remains to integrate the three waters and use water sensitive techniques.

6.3.1 Water Supply

Integration of the water supply and stormwater system is most easily achieved by stormwater harvesting. The current water take consent limits, strategic water network and the reticulation are adequate to meet future demands. However, climate change predictions indicate that Hamilton will become drier for extended periods.

There is no need to require wide scale stormwater harvesting to meet system demand but there are several benefits of encouraging uptake of a harvesting system such as:

- Reduced peak flow impacts due to fast response runoff from impermeable areas
- Reduced water taken from the water source
- Lower treatment and network operational costs
- Maximum use of the existing Water Treatment Plant but with the potential to delay future upgrades

Rain tanks are often used to collect stormwater for re-use. Hamilton has an adequate raw water source to supply the city, but extreme drought conditions could one day result in severe restrictions. Rain tanks can be used as an emergency supply in such conditions, or during other disasters (i.e. earthquake).

The use of tanks for stormwater collection and re-use outdoors is encouraged due to the aforementioned reasons. Connection into household plumbing (i.e. for toilet flushing) is also encouraged for new buildings to further reduce water use.

6.3.2 Wastewater

Integration of wastewater is not as easily achieved as stormwater and water. Initiatives such as greywater re-use or disposal on-site are viable but come with special operational requirements to mitigate public perception and public health. To have a measured effect while remaining controlled, such initiatives generally need to be implemented with guidance or control by the network authority (Council).

In areas with a public wastewater collection network, on-site disposal or re-use of greywater is not normally encouraged but is of benefit for integration and minimisation. Treatment of solids on-site would not normally be permitted.

The existing local collection network is adequate to meet future demand needs from the catchment. The strategic wastewater network but the treatment plant will be under pressure in the future so volume minimisation will be beneficial.

Consequently, there is a case to encourage wide scale wastewater disposal or re-use at source to reduce wastewater in existing interceptor pipelines and the treatment plant. Due to complexity and health, it is not yet warranted as a mandatory requirement. The collection of household greywater for disposal by soakage, or for use in the garden will be encouraged but not mandatory.

7 Three Waters Management

7.1 Management Principles and Hierarchy

Management principles that should form the basis of sustainable urban development include:

1. Minimise disturbance of soils and preserve and recreate natural landscape features
2. Stormwater disposal mimic the natural drainage processes that currently exist
3. Modifications to existing natural drainage patterns kept to a minimum
4. Riparian margins to be designated planted and protected
5. Impervious area increases should be kept to a minimum
6. Disconnect impervious surfaces
7. Utilise conveyance and stormwater treatment methods that also provide ecological and amenity benefits.

HCC's established hierarchy for the management of the three waters is as follows.

Minimise Demand → Re-use → Treat & Dispose to Ground → Treatment & Detention → Reticulation

In accordance with District Plan rules water sensitive principles are required to be incorporated into all development proposals.

7.2 Option selection

Options that will meet operational objectives and cover the nature of the issues and discharges arising from the catchment are provided. Examples which make an option viable include the following:

1. Technical feasibility.
2. Ability to meet relevant legislative requirements and be consistent with the principles of the Waikato Tainui Environmental Plan.
3. Aligned with the catchment specific objectives outlined in this document.
4. Must not have greater negative environmental, social, or cultural consequences than doing nothing.
5. Does not contravene any explicitly stated political objective and does not result in an increase in risk.
6. Does not increase health and safety risks compared with doing nothing.

A number of viable options for each issue are provided[28]. For new developments the preferred option or options shall be implemented in accordance with this ICMP and HCC District Plan. For objectives and options related to existing developed areas, a prioritised programme of capital works and additional investigations is developed.

7.3 Best Practicable Option

The CSDC[29] requires an integrated catchment management approach based upon the Best Practicable Option (BPO) to meet strategic and operational objectives of this ICMP. BPOs are developed and incorporated into the Best Management Practices and solutions in Section 11 .

7.4 Rototuna Structure Plan

The following has been summarised from the District Plan:

> *Indicative locations for centralised key stormwater management facilities are shown in the Rototuna Structure Plan. The precise location of these stormwater management facilities will be finalised via detailed catchment management planning and modelling at the time of consent.*
>
> *Stormwater management must provide for the management of all stormwater within the land being developed, together with drainage from the entire catchment upstream of the proposed system as per the requirements of the Hamilton City Council Infrastructure Technical Specifications. Developers will need to demonstrate how stormwater from a development will be discharged to the centralised stormwater management facilities, indicated on the Structure Plan.*
>
> *There are a number of high-level stormwater principles which form the basis for the approach to stormwater management in the Rototuna area:*
>
> *a) Stormwater is managed in a manner that minimise the effects of urban development on downstream receiving waters.*
> *b) Stormwater run-off from the different relief and soil types is managed in an integrated manner.*
> *c) Stormwater should, as far as practicable, be used to sustain groundwater levels in peat soils.*
> *d) Stormwater management should seek to safeguard and enhance areas of indigenous vegetation, water features and habitats.*
> *e) Stormwater discharges should, as far as practicable, result in a hydrological cycle as close to the pre-development hydrological cycle as possible.*

[28] MCA assessment is usually carried out except where (1) the catchment is already developed or mostly developed and remaining development will be in accordance with what has already been implemented, (2) Multiple viable options exist and it is not appropriate to specify a single outcome (3) An issue only has one viable solution.

[29] Condition 30(j)

Te Awa o Kātāpaki Upper Catchment
In the upper catchment area, appropriate stormwater treatment will involve stormwater management facilities shown indicatively on the Structure Plan, and a centralised drainage reserve/watercourse through the Town Centre, with appropriate flow attenuation measures, along with ground soakage.

The central drainage reserve/watercourse of the Rototuna Town Centre has a principal stormwater function but also provides a key green corridor and walkway/cycle way link and must be designed as an attractive feature. To the north, the watercourse/drainage reserve will connect with the Active Recreation Reserve and provide a green edge to the playing fields and the secondary school to also accommodate shared pedestrian and cycle routes.

The Rototuna Town Centre Design Guide refers to requirements around the design of the drainage reserve/ watercourse corridor through the Rototuna Town Centre. The precise form and function of the drainage reserve/ watercourse and corridor will be determined by hydrological requirements and controls. Developments must demonstrate how stormwater will be directed to the drainage reserve/watercourse and stormwater management facilities shown on the Structure Plan and Concept Plan.

Te Awa o Kātāpaki Lower Catchment
In the lower catchment (the south western area of Rototuna) stormwater must be discharged directly to the Te Awa o Kātāpaki Stream or to ground soakage, and attenuation ponds should be avoided.

Refer to the Rototuna Structure Plan for more detail[30].

7.5 Level of Assessment for this ICMP

Because most of this catchment has been either developed or consented for development, a full MCA analysis has not been undertaken for all aspects. The environmental aspects of three waters infrastructure will be appropriately managed in accordance with the following hierarchy using standard solutions approved for use by HCC.

a) Water use reduction (potable water)
b) Retention and re-use (stormwater only)
c) Soakage techniques (stormwater only)
d) Treatment and release to a watercourse (stormwater only)
e) Treatment and release to stormwater reticulation (stormwater only)

New or upgraded infrastructure may be needed to provide the required level of service while accommodating new development. Where more than one option exists, infrastructure is assessed based on capital, operational and maintenance costs. Where a single viable option exists, it is identified with discussion as to why.

[30] https://www.hamilton.govt.nz/our-council/council-publications/districtplans/ODP/chapter3/Pages/3-5-Rototuna.aspx

8 Stormwater – Best Practicable Options

The ideal stormwater management system for a developed site is one that replicates the undeveloped scenario. In practice, with the introduction of new impermeable areas, alterations to flow paths and concentration of flows, a developed site's hydrology will never truly replicate that of the undeveloped state.

Stormwater discharges within the catchment are as follows:

- Urban roading
- State Highway (Waikato Expressway)
- Residential
- Commercial (Town Centre)

BPOs have been developed based on the structure plan information and specific catchment information.

BPO – Attenuation and extended detention
Lower and River North Catchments – extended detention and volume control only, no attenuation of larger events
Upper and Southern Catchments – extended detention and volume control and attenuation of larger events is required

8.1 Standard Solutions for Treatment Devices

In the NIWA CLM assessment (Section 3.13) several devices and combinations were tested against baseline conditions from an assessment carried out by NIWA (2000). The following Scenarios were modelled:

- 2000 Baseline
- 2014 Existing
- Developed unmanaged - Existing stormwater features operational. Development after 2014 uncontrolled (not treated)
- Six Options for new development to be treated by various combinations of devices.

For each of the options, existing development remains as is and where treatment devices exist, they are well maintained. The options listed below apply to new development areas.

- Option 1 (preferred) – Centralised wetlands prior to discharge (one per sub-catchment) and compliance with water sensitivity District Plan rules.
- Option 2 – On-lot treatment by way of roof water re-use and rain gardens for hardstand and one centralised wetland prior to discharge per sub-catchment.
- Option 3 – as above but inclusive of road treatment catchpit filters.
- Option 4 – same as option 2 but inclusive of road treatment swales.
- Option 5 – same as option 2 but road treatment rain gardens.
- Option 6 – same as option 2 but road treatment swales and catchpit filters.

8.1.1 Catchment Approach - Treatment Devices

HCC have undertaken assessment and selection of preferred stormwater treatment devices citywide and for this catchment. In alignment with the requirement for assessment of best practicable options (consent 105279, c30 (j)) for preventing or minimising the adverse effects of stormwater on this catchment, and meeting operational objectives, the following nine criteria have been considered:

1. The expected contaminant loading.
2. The state, sensitivity of Te Awa O Kātāpaki Stream, its geology and ecological value.
3. Treatment and attenuation effectiveness in conjunction with capital, operation, maintenance, and renewal costs.
4. Long term financial implications of various devices to be borne by the city and private property owners.
5. The extent of existing built environment.
6. The extent of undeveloped land in the catchment which has not been subject to at least initial planning and engineering consideration or discussion and planned development.
7. The potential or need for retrofitting in the built catchments.
8. The current state of technical knowledge of various options and the likelihood that the option can be successfully applied.
9. Alignment with the Rototuna Structure Plan.

The NIWA CLM assessment showed that although a treatment train approach will have a positive effect, it is not significant (due to the level of existing development). Treatment of roads is more beneficial than treatment of discharges from private lots. Based on a high-level assessment of the 411-hectare upper catchment, the capital cost to implement swales or catchpit filters would be in the order of $8-12M with annual operational costs of $600-800k.

Option 1 is the preferred minimum standard for the catchment because it provides a marked increase in discharge quality (compared to doing nothing) and is consistent with existing development while complying with District Plan rules. Based on the assessment, a single centralized treatment device per sub-catchment is considered the best practicable option, subject to site constraints (additional devices will be required to achieve volume control). Devices are to be located and sized to ensure design flows are captured, managed, and operated and maintenance costs are kept to a practical minimum. Devices are to be consolidated where reasonably possible. These may be shifted slightly or have layouts revised from the locations shown in the ICMP but will generally not be split or have substantial changes to catchment delineation unless it can be demonstrated that these are necessary due to site constraints. In most cases, stormwater devices will cater for multiple developments. A wetland is HCCs preferred centralized treatment device and does not result in lower standards for new development.

This solution provides HCC with the best overall value and treatment outcome. Wetlands can also accommodate the required attenuation volumes cost effectively, without the need for multiple devices and/or locations. This is also consistent with development already carried out or consented in the Southern Catchment and the Upper Catchment.

BPO – Stormwater Management Devices
Preferred single centralised device – one wetland per development sub-catchment, subject to sub-catchment constraints. Additional devices will be required to achieve volume control. Utilise water sensitive devices as required or encouraged by the district plan.

BPO – Stormwater Treatment
Device design in accordance with the RITS (or other equivalent document) to achieve a minimum of 75% removal of suspended solids and by-product removal of other contaminants

8.1.2 Future Catchment Approach

Where ICMP monitoring shows that there is a negative trend, the ICMP best practicable options will need reassessment. This is likely to necessitate some or all of the following:

- Characterise the receiving environment (water quality, habitat quality, risks, and sensitivities) and revise ecological objectives.
- Characterise catchment land use impacts (contaminant loads and water quantity, water chemistry and quality).
- Identify site conditions constraining the use of management devices not already implemented in the catchment (area specific).
- Assess the performance of existing devices.
- Select new BPOs or revise existing BPOs to meet revised objectives within site constraints.
    - In a developed catchment this could include revisions to the discharge standards (to be implemented through device retrofit or additional devices), mitigation through planting and restoration and increased enforcement measures where those tools are available.

8.2 Flood mitigation and attenuation standards

Existing treatment ponds and wetlands in the lower catchment do not attenuate for flood mitigation, nor is this a requirement. Future development in the lower catchment is permitted to discharge directly to the stream without attenuation provided that extended detention, volume control and treatment is provided. Extended detention and water quality treatment in a wetland (HCCs preferred solution) results in some attenuation of larger events.

It has been established that environmental attenuation is required in the upper catchment. Attenuation in the upper catchment will reduce the coincidence of peak flows in the lower catchment to reduce environmental impacts. Flood attenuation, for storm events in excess of 10-year ARI, is required in the Upper east sub-catchments that discharge to the Borman Road pipeline to reduce the potential flood risk along Borman Road.

HCCs preferred device for stormwater treatment is a single wetland, subject to sub-catchment constraints. The provision of additional wetland volume for attenuation is typically more cost efficient than other methods (i.e. underground storage). Based on one wetland per development sub-catchment, the assessment of other device options to provide attenuation has not been undertaken.

BPO – Flood Attenuation
Attenuation of storm events in excess of the 10-year ARI is only required in the Upper east sub-catchments that discharge to the Borman Road pipeline.

BPO – Environmental Attenuation / Stormwater Quantity Management

Upper and Southern Catchments – Attenuate to pre-development flow for the 2-year & 10-year ARI storm events
24 hour extended detention and volume control is required in all development sub-catchments except for approved direct discharge to the Waikato River

8.3 Resolution Drive Sub-catchment

Surface flooding is predicted in the southern portion of the Resolution Drive development sub-catchment ad described in Section 3.10. The flooding is a function of capacity in the local primary stormwater network and the elimination of natural overland flow paths by the barrier effect of Borman Road.

Three options exist to reduce flooding, including reinstating the overland flow path via a new culvert, upgrading the local stormwater network or by storing excess flood water in a local detention basin (reserve).

Preliminary estimates indicate that a 1200 mm diameter culvert is required. Table 8-1 presents high level cost estimates for the three options. The network upgrade option is based on duplication of the existing network with a parallel 1200 mm diameter pipeline. Note that the cost of detention is highly variable dependent on topography, network levels and flood volumes; the estimate below has a high margin of uncertainty but is enough to demonstrate the relative scale of cost.

Table 8-1 – Resolution Drive sub-catchment – flooding solutions

Option	Estimated Cost
1200mm diameter Culvert under Borman Road to Tuirangi Floodway	$80-100k
Network upgrade (duplication by the addition of a parallel 1200mm)	$700-800k
Detention of floodwater in a local detention area - including associated loss of developable land	$500-900k

A culvert is the most cost-effective solution for the flooding issues predicted in the catchment.

BPO – Resolution Drive Sub-catchment Overland Flow
Install a culvert adjacent to the Borman Road – Resolution Drive Roundabout to convey flood flow direct to the Tuirangi Floodway.

8.4 Stormwater Management Options – River Road North

8.4.1 Featherstone Park / River Gardens

Figure 27 shows the existing overland flow paths and minor gullies alongside the Waikato River in River North that should be retained.

Figure 27 – Featherstone Park – discharge gullies

Viable treatment methods prior to discharge could include centralised wetlands at up to three locations or at source treatment of hardstand (on-lot) and roads via rain gardens or similar approved devices. The final service areas extents and location of treatment devices will be subject to developed topography.

Refer to Plan 012 in Appendix C for proposed wetland locations. There are three options for discharge which are identified in Table 8-2.

Table 8-2 – Featherstone Park Discharge Options

Discharge type	Benefits	Negatives
Soakage	• No environmental impact on gully • Attenuation not required • Very low capital infrastructure cost and loss of developable land	• Soakage feasibility needs to be confirmed for individual lots
Direct to River	• No environmental impact on gully • Attenuation not required • Likely to have the lowest capital infrastructure cost and loss of developable land in comparison to the gully discharge option	• Future maintenance of river outlet likely to be costly and complicated • Structures in the river are not preferred by HCC or the Waikato River Authority
Via gully system	• Buffer between treatment and discharge to the river • No structures in river	• Potential environmental impact on gully

	• Easier to consent than a structure in the river • Maintenance of the gully system is easier than maintenance in the riverbed. • Ongoing compliance with consent conditions is likely to be easer once the assets are vested.	• Likely to have the highest capital infrastructure cost and loss of developable land

BPO – Featherstone Park Discharges
Soakage is preferred for all lots, particularly those at lower elevations near the river that are unable to be connected to a public network.
Treated and controlled discharges to existing gullies and drains are preferred over a new public piped discharge to the Waikato River provided.
Individual lots may discharge direct to the Waikato River, but individual owners will be responsible for obtaining consents and approvals for the discharge and for ensuring the requirements of this ICMP and the building code are met.

8.4.2 River Road Properties

Several individual developed lots alongside River Road discharge directly to the Waikato River and the lower Te Awa O Kātāpaki without a primary piped system. The area is indicated on Plan 012 and is not currently serviced by a common primary piped system due to topography which slopes away from River Road.

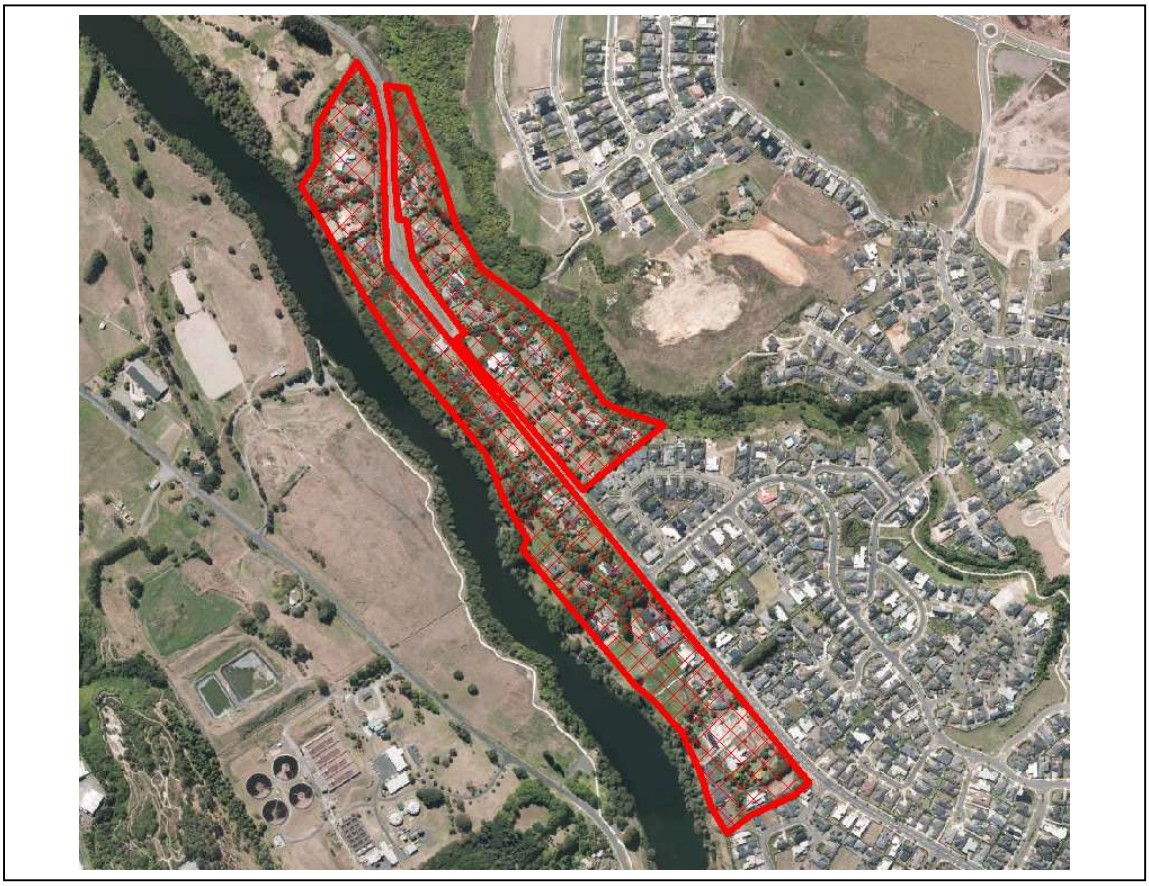


Figure 28 – River Road properties without a primary stormwater system

If development or subdivision occurs, it is not likely to be practical to construct a common primary piped system. In the first instance, properties shall be serviced by soakage systems. Because there is no primary piped system, soakage of the 10-year, 1-hour event in accordance with E1 is appropriate. If comprehensive soakage is not viable, properties will need to discharge excess stormwater without adverse effects on adjacent property (in accordance with the NZ Building Code, Clause E1).

BPO – River Road Properties
Soakage is preferred for all lots, particularly those at lower elevations near the river and unable to be connected to a public network.
Individual lots may discharge direct to the Waikato River or the Te Awa O Kātāpaki Stream, but individual owners will be responsible for obtaining consents and approvals for the discharge and for ensuring the requirements of this ICMP and the building code are met.

9 Best Practicable Options - Wastewater

Wastewater shall be treated and disposed of in a way that minimises effects on public health, the environment, and cultural values. Wastewater discharges within the catchment are as follows:

- Residential
- Commercial (Town Centre)
- Schools

9.1 Wastewater Management Options

Except for existing properties on septic tanks at the northern end of River Road, undeveloped areas of the Te Awa O Kātāpaki and River Road North catchments will be serviced by the existing gravity wastewater system. New collection networks shall be conventional gravity as per the existing system serviced by new pump stations only where it is not practical to service by gravity to the existing network.

Notwithstanding the above, viable options exist for a more sustainable and integrated approach. Alternative technologies may be proposed and then adopted based on HCC's preference and approval.

BPO – Wastewater collection and conveyance
Collection and conveyance shall be via gravity, or pumped where gravity is not feasible, to the existing HCC network in accordance with the RITS.
Properties identified as not being able to be serviced by a public wastewater system may be serviced by a private pump station which discharges to the HCC network, by approval.

BPO – Wastewater reduction and re-use
Alternative wastewater technologies which enable re-use or reduction may be proposed but are not mandatory.
On-site wastewater disposal is not permitted unless a public system cannot be provided and Regional Plan rules for on-site disposal can be met.

9.2 River Road North of Te Huia Drive

Within the area as shown on Plan 010 in Appendix C, existing properties are over 2500 m^2 and are serviced by septic tanks. Future Subdivision of these properties could retain septic tanks provided lot sizes remain greater than 2500 m^2.

Figure 29 – River Road properties without a primary wastewater system

If subdivision does occur there are two viable options to service, the area with a public wastewater system as follows:

1. Construct a gravity pipeline north along River Road to a new pump station in the vicinity of the River Road culvert. Some low-lying properties next to the Waikato River will require private pumps for this option.
2. Construct private pump stations discharging to a low-pressure sewer in River Road.

A rough order cost analysis has been undertaken for the two options, based on construction of the centralised infrastructure now or in the future. It has been assumed that a gravity pipeline and blank connections will need to be installed concurrently with the urbanisation of River Road in year 1.

Table 9-1 – River Road North Wastewater Options

Case	Description	Estimated net present value (±25 %)
1	Construct a gravity pipeline and rising main now, construct public pump station and connections in year 10. Lots serviced by gravity where feasible or private pump.	$1,910,000
2	Construct a gravity pipeline now, construct rising main (by trenchless technology) and public pump station and connections in year 10. Lots serviced by gravity where feasible or private pump.	$1,870,000
3	Construct a public low-pressure sewer now. All lots serviced by private pump from year 10.	$2,070,000
4	Construct a public low-pressure sewer in year 10 (trenchless technology). All lots serviced by private pump from year 10.	$2,050,000

Note: estimated costs include private on-site infrastructure.

Case 1 and Case 2 don't include the potential cost of land for a public wastewater pump station. Land purchase may be required in the vicinity of the River Road culvert for this purpose.

The overall cost of a conventional gravity or low-pressure system does not differ significantly. The timing of construction also does not have a significant effect on the overall cost. Therefore, the servicing solution does not need to be predetermined, but it would be cost effective to install all public pipeline infrastructure at the same time as River Road is urbanised.

A conventional gravity system draining to a pump station is preferred in line with HCC standards.

BPO – River Road North Wastewater
Design and construct a gravity pipeline (with blank connections) and a rising main as part of the urbanisation of River Road.
Construct a public wastewater pump station in the vicinity of the River Road Culvert, at a time to suit development.
Construct gravity laterals or private pump stations as required to coincide with development.

9.3 Rototuna West Pump Station (Borman Road West)

The Rototuna West wastewater pump station was constructed in 2012 at a reduced scale to accommodate initial development. The wet well was designed to accommodate three pumps (2 duty + 1 standby) but currently has two pumps installed (1+1).

The future catchment area, storage volume, design flows and pump selection is not documented. An assessment has been undertaken based on the installed equipment and the serviced catchment shown on Plan 011.

Table 9-2 – Rototuna West WWPS

Item	Parameter / Requirement
Catchment area	94 Hectares
Design Peak Wet Weather Flow	45 L/s
Installed Pump	2 No. NP3153 HT 450 (13.5kW)

Installed Rising main	DN225 PN16 PE100
Installed storage	Nil
Theoretical capacity	34-43 L/s (single pump, duty operation) 40-55 L/s (two pumps, future duty operation)
Required Storage	265 m^3 (inclusive of network storage)

Except for emergency storage, the pump station has enough capacity to service anticipated development. The option to install a third pump may be required near maximum development but this need not be assessed now. Wet weather run times and the frequency of use of storage will be monitored to determine if the third pump should be installed.

BPO – Rototuna West WWPS
Pump station capacity upgrades are not required. Wet weather operation should be monitored near maximum development to determine the need for a third pump.
265m^3 of emergency storage shall be provided as additional storage or within the upstream network.

9.4 Moonlight Pump Station (Borman Road East)

The Moonlight wastewater pump station was constructed circa 2007 to service the upper east catchment. The future catchment area, storage volume, design flows and pump selection is not documented. An assessment has been undertaken based on the installed equipment and the serviced catchment shown on Plan 011.

Table 9-3 – Moonlight WWPS

Item	Parameter / Requirement
Catchment area	140 Hectares
Design Peak Wet Weather Flow	68 L/s
Installed Pump	2 No. NP3153 MT 434
Installed Rising main	DN200 PN16 PE100
Installed storage	Nil
Theoretical capacity	60-68 L/s (single pump, duty operation)
Required Storage	400 m^3 (inclusive of network storage)

Except for emergency storage, the pump station has sufficient capacity to service anticipated development.

BPO – Moonlight WWPS
Pump station capacity upgrades are not required.
370m^3 of emergency storage shall be provided as additional storage or within the upstream network.

10 Best Practicable Options - Water Supply

Consideration of the water supply includes conservation and demand management in addition to network and supply. Water supply infrastructure shall be designed and constructed to meet consumption, hygiene, water-sensitive design, and firefighting requirements. Water demand within the catchment comes from:

- Residential
- Commercial (Town Centre)
- Schools

Undeveloped areas of the Te Awa O Kātāpaki Catchment will be serviced by the existing water system. New distribution networks shall be compatible with the existing system in accordance with the HCC Infrastructure Technical Specifications.

HCC's minimum development requirement is for low flow water fixtures to be installed in new buildings. The installation of low flow fixtures is accepted practice and not subject to assessment against other options (the cost of standard fixtures is no longer significantly less).

On-lot rainwater tanks and water re-use is encouraged but not mandatory. The recommended rainwater tank size is consistent with published guidance[31] which generally shows that rain tanks of 3,000 L to 5,000 L provide the optimum roof runoff capture in relation to tank size and therefore cost.

Because rainwater tanks are encouraged but not mandatory, a cost benefit assessment against other devices has not been undertaken. Studies undertaken by Auckland Council[32] indicate that rain tanks contribute to higher overall costs than wetlands and other device types (swales, rain gardens).

BPO – Water Conservation and Re-use
Low flow water fixtures shall be installed in all new buildings. Rainwater tanks are encouraged for garden watering and toilet flushing.

[31] Auckland Council Technical Publication 10, Chapter 11

[32] Auckland Unitary Plan Stormwater Management Provisions: Cost and Benefit Assessment, December 2013 Technical Report 2013/043

11 Best Management Practices (BMP)

This chapter reflects historic practice and what was proposed. Catchment specific issues that have been evidenced, or now constructed have been retained in this chapter. Remaining elements have been updated to refer to the RITS for current best practice.

The strategic and operational objectives plus the Best Practicable Options form the basis of the catchment requirements. This section provides details of the BMPs to be implemented in the catchment which are likely to meet the objectives.

11.1 Stormwater

This section provides details of the water BMPs that have been selected to achieve the objectives for the catchment. In the application of these practices, consistency with HCC's stormwater management hierarchy and SWMP is required.

The BMPs organise and integrate the management options, existing standards and consented devices into a servicing approach that addresses issues and objectives in the catchment. This integrated approach to managing stormwater diversion and discharge activities is a key requirement of the CSDC Condition 30.

Stormwater BMP 1 – Water Sensitive Techniques

a. Developers shall incorporate water sensitive design devices in accordance with Council's Three Waters Management Practice notes.

b. Consideration is to be given to clustering.

Stormwater BMP 2 – Soakage

a. Soakage shall be the primary method of disposal unless it is proven not to be feasible.

b. Developers shall undertake sufficient testing to determine if suitable soakage characteristics are present. Test results shall be provided to HCC. Guidelines on requirements for soakage testing and design are provided in HCC's RITS.

Soakage (with pre-treatment) is still required where there is a seasonally high-water table (e.g. July-September) as soakage during summer is a key means to protect the receiving environment from pulses of runoff. A secondary device is to be provided which will allow the attenuation requirements of the development to be met when the water table is high.

c. Contamination of groundwater due to intensive activities (e.g. commercial hardstand, vehicle wash bays, trafficked areas) shall be mitigated through the use of appropriate treatment in advance of any soakage system

d. Consideration is to be given to minimising impermeable areas through the use of permeable surfacing (i.e. permeable paving or concrete in carparks or large areas of hardstand).

e. Also refer to Stormwater BMP 12 – Soil rehabilitation.

Stormwater BMP 3 – Catchment Wide Treatment

a. A treatment train approach shall be considered for all developments within the catchment area. This may include the use of on-lot devices and at-source devices in the carriageway/drainage reserves prior to discharge to the centralised treatment device.

b. The system as a whole is to achieve the discharge parameters specified in Section 12.2.

c. Devices servicing high traffic roading and upgraded roads shall be suitable for the removal of traffic generated contaminants, including hydrocarbons, heavy metals and suspended solids. If the main central device is not suitable to remove hydrocarbons, additional devices shall be implemented within a treatment train.

d. High risk sites (i.e. those with the potential for the discharge of unusual or high concentration contaminant runoff) shall have their own comprehensive treatment system prior to discharge from the site.

Stormwater BMP 4 – Reticulation Systems

a. With the exception of specified properties in River North, all sub-catchments require a reticulated system to be provided. Reticulation systems are to be designed on a sub-catchment basis with independent developers working together to achieve this.

b. Reticulation systems and associated structures and devices shall demonstrate full consideration of public safety, and ease of access for maintenance.

c. The reticulated system will generally need to provide connections to all lots and the road network. It will need to be capable of conveying peak runoff flow from the primary system design storm, from the road reserve and post developed flows from the lots, without surcharging. Refer to the RITS for design storms for residential, industrial, and commercial.

d. Where the developer has undertaken sufficient soakage investigations (Refer Stormwater BMP 2b) and can demonstrate that relevant lots can satisfactorily dispose of stormwater to ground (or via other means such as re-use) for up to the 1 hour primary system design storm event (refer to the RITS), and suitable conditions exist to dispose of road runoff via soakage, then reticulation may not need to be provided for that section of the development.

e. For residential infill development where there is no downstream device to provide attenuation, connection points provided to lots shall reflect the requirements of the RITS and consider detention and flow restriction to undeveloped runoff rates within the private on-lot infrastructure.

f. A primary reticulated system is not required where it is not practical to construct a reticulated system and single lots discharge directly to a water body. Treatment and attenuation shall be carried out in accordance with the Means of Compliance table 12-2 in Section 12.3.

g. Operation and Maintenance plans shall be submitted to HCC for approval with the engineering plans for any reticulation element that is a proprietary device with manufacturer specified operation and maintenance requirements.

Stormwater BMP 5 – Centralised Devices – Type and Location

a. The reticulation system for each sub-catchment shall drain to a downstream centralised device except where the required level of treatment and attenuation has been achieved in preceding

devices, or where sub-catchment constraints require multiple centralized devices. Volume control will need to be provided in devices other than the centralized wetland that will need to be located in the carriageway or drainage reserves.

b. Wet ponds will not be acceptable for this catchment. Wetlands shall be used for all ponds holding water for an extended duration.

c. Dry ponds shall not be used to meet water quality objectives. Wetlands with an attenuation function are preferred; approval to use a dry pond shall be sought from HCC as early in the planning phase as possible.

d. Dry ponds are only permitted for the purpose of short duration attenuation where treatment will be achieved in another device. Dry ponds shall not be used for the purpose of extended detention.

e. Dry ponds shall be located in public reserve land and shall integrate with the area so that they form part of the useable reserve area when not in use. A buried primary pipe system with an overflow, or similar, may be required to achieve this.

f. If a dry pond is proposed for attenuation purposes, the pond shall not hold water for more than 24 hours. HCC may consider longer durations where catchment conditions preclude the use of other types of devices for attenuation.

g. No development sub-catchment should contain more than one wetland area (unless sub-catchment constraints require multiple centralized devices) and developers will need to work together to achieve this. Refer to plan 012 in Appendix C for indicative location of devices.

Stormwater BMP 6 – Centralised (Wetland) Devices – Water Quality

a. Each wetland shall provide Water Quality Volume (WQV) and Extended Detention Volume (EDV). A reduced requirement of 50% WQV is allowed when EDV is provided.

Stormwater BMP 7 – Runoff Volume and Attenuation

a. Peak flow attenuation of the 2-year, 10-year and 100-year ARI storms shall be undertaken in accordance with RITS. The outcome is to have peak flow rates and velocities that are the same as, or lower than the pre-development situation (flows may be lower where soakage or re-use is effective).

b. Appropriate energy dissipation shall be provided at all outfalls and overland flow path discharge locations to gullies, to minimise erosion.

c. Increased runoff volume from developed areas shall be minimized where practical (i.e. using soakage). As a minimum, retention of the initial abstraction volume is to be retained (via soakage or reuse), this is also called volume control. Where volumes cannot be practically reduced, mitigation within the receiving environment will be required (e.g. through contributions to channel stabilisation projects).

d. Extended detention, volume control and attenuation are not required for direct discharges to the Waikato River.

Stormwater BMP 8 – Wetland Design Parameters

a. To reduce adverse effects of warmer water being discharged to the stream, wetland areas shall be planted to provide shading, prior to the final outlet.

b. Wetland designs shall demonstrate full consideration of public safety, and ease of access for maintenance. HCC has a strong preference for benching and heavy planting rather than fencing, however, in some locations, fencing will be required. Access to the wetland forebay shall be provided as per the requirements of the RITS.

c. A well planted, generous riparian margin, as detailed in the RITS, shall be included to deter waterfowl and children from entering the wetlands.

d. An Operation and Maintenance plan shall be submitted to HCC for approval with the engineering plans for each wetland area. A standard template is available for this purpose.

Stormwater BMP 9 – Overland Flow

a. Each sub-catchment shall be designed with suitable overland flow paths, in accordance with the RITS.

b. Where feasible, overland flow should occur within the roading network or through designated paths in public reserve.

c. The number of overland flow discharge locations to the gully system shall be minimised, and developers will need to work together to achieve this.

d. To minimise erosion potential, overland flow discharges to the gully system shall be designed to operate as dispersed flow as opposed to concentrated flows. Suitable energy dissipation and/or erosion protection measures shall be provided.

e. Overland flow paths shall discharge directly to receiving environments (River, Te Awa o Kātāpaki Stream, Tuirangi Floodway, or the Rototuna Town Centre Channel) with appropriate erosion protection.

Stormwater BMP 10 – Fish Passage and Habitat Enhancement

a. All culverts and structures shall be designed to optimise the upstream and downstream passage of native fish. Refer to Waikato Regional Council Reports TR 2006/25R and TR2014/29 for design principles to optimise fish passage.

b. No structure (treatment or otherwise) shall be constructed in the Te Awa O Kātāpaki Stream gully downstream of the Magellan Lake discharge weir without approval from Hamilton City Council and Waikato Regional Council.

c. All stormwater devices or channels holding permanent static or flowing water shall include for shade planting to reduce the effects of temperature increases on the receiving waters.

d. Where it is identified that stormwater discharges may be having an effect on natural fish habitat, then fish habitat enhancement shall be included as a mitigation measure. Fish habitat enhancement measures may include online (within channel) or in flood prone areas offline (within bank) artificial or natural devices for replacing or enhancing habitat for fish in urban streams.

Note: For installation of such devices in urban streams it is highly recommended that a qualified river geomorphologist and aquatic ecologist participate in the design and implementation of engineering solutions to ensure long term performance and effectiveness.

Stormwater BMP 11 – Retention and Enhancement of Existing Riparian Areas and Vegetation

a. Existing areas of riparian vegetation coverage are to be retained (including gully floors, vegetated springs, and seeps).

b. The main stream course or the riparian corridor is not to be used to locate stormwater treatment devices in addition to those already installed as at March 2014. The riparian corridor downstream of Magellan Lake shall be considered as a no-go zone for any form of development or physical works not associated with consented remedial work.

c. Existing riparian vegetation shall be protected and enhanced, and unplanted riparian margins planted with appropriate vegetation. Refer to HCC's 'Gully Restoration Guide Document, 3rd edition, June 2006' and 'Waikato Regional Council Technical Report 2007/41 - Best Practice Guidelines for Vegetation Management and In Stream Works' for guidance on gully enhancement and plantings.

d. The riparian corridor is generally defined as the land between the top of the gully banks on each side of a perennial stream[33].

Stormwater BMP 12 – Soil Rehabilitation

a. Soils shall be rehabilitated upon completion of construction to reverse compaction effects and to improve near surface soakage. Refer to '*Guidelines and Resources for Implementing Soil Quality and Depth BMP T5.13 in WDOE Stormwater Management Manual for Western Washington, 2010 Edition*' or Section 8.5.11 of WRC's Waikato Stormwater Management Guideline.

b. A minimum depth of 200mm of un-compacted topsoil shall be left across the full extent of each residential property except pan handle driveways.

c. Consideration is also to be given to minimising earthworks and site disturbance.

Stormwater BMP 13 – Construction Controls

a. Sediment control measures shall be in accordance with WRC requirements and must protect the Te Awa O Kātāpaki Stream and its tributaries, plus any existing stormwater treatment devices (such as catchpits, swales, and wetlands). These requirements are aimed at reducing the amount of sediment leaving construction sites, as the construction period is when most sediment runoff can occur.

b. Monitoring of earthworks for house builds will be implemented by HCC. Controls on stormwater runoff from lots during construction will be required to keep sediment out of the system. This will protect the stream and the integrity of stormwater management devices.

c. No work shall occur in a natural water course or water body known to contain fauna. However, if this is permitted to occur by special arrangement, all fauna shall be collected and relocated to the satisfaction of HCC and WRC.

Stormwater BMP 14 – Education

a. Education measures shall be applied to ensure that community are aware of the need to protect receiving waters within the city boundary. This shall be done in accordance with the HCC Education Strategy and WRC Strategy.

[33] Developers are also encouraged to speak with WRC and any relevant stream care group to determine extent of the riparian corridor in the area prior to any consent application for that area.

b. The ICMP shall be listed within the HCC Education Strategy for further assessment on appropriate public communications plan.

c. As a minimum, the ICMP shall be placed on the HCC website and documented in planning documents.

d. As a minimum the finalisation or major update of the ICMP shall be communicated externally and internally with key stakeholders.

Stormwater BMP 15 – Application of RMA, LGA, DP and Bylaws

a. Appropriate legislation and regulation measures such as bylaw[34] enforcement and district plan rules shall be applied to maintain and protect the catchments receiving waters.

Stormwater BMP 16 – Management under the Citywide Comprehensive Stormwater Discharge Consent

a. Management of the area shall align with requirements of the citywide comprehensive stormwater discharge consent and associated HCC Stormwater Management Plan.

Stormwater BMP 17 – Development Setback

a. New development shall be set back a minimum of 10m from the top edge of existing gullies. This will protect property against instability, permit access for remediation and improvement, plus it will provide a nominal zone atop the gully in which riparian planting may be extended.

b. New development shall be set back a minimum of 15m from the bank full extent of existing or proposed stream and open watercourses. This will permit access for remediation and improvement, plus it will provide a nominal zone in which riparian planting can occur.

c. The prescribed setback may only be decreased upon approval of a recommendation with justification by a suitable expert.

d. Note that larger setbacks may be require for other reasons such as, but not limited to, safety buffers to stormwater devices, avoidance of development within flood extents, screen planting, or unusual geotechnical risk.

11.2 Wastewater

This section provides details of the wastewater BMPs that have been selected to achieve the objectives for the catchment.

The catchment can be served by the existing city network with the addition of new collection pipelines and pump station (see Appendix C). The network will be extended as development occurs in accordance with the RITS and assessed during the engineering phase.

The size of infrastructure should be minimized by promoting sustainable water use and where possible, three waters networks are integrated within the catchment prior to discharge to the wider city networks. Future infrastructure upgrades shall be minimised by preventing, identifying and managing inefficiencies such as leakage, inflow and infiltration, and unauthorised use.

[34] Stormwater bylaw in development, implementation dependant on statutory processes.

Wastewater BMP 1 – General Requirements

a. An adequate, reliable, safe, and efficient wastewater service shall be provided.

b. Where any subdivision or development results in additional allotments or buildings to be used for urban purposes, provision shall be made for a wastewater collection system as follows.

   i The installation or upgrading of the wastewater network and/or wastewater pump stations to serve all proposed allotments and/or buildings, and

   ii Connection to the wastewater network from each proposed allotment or building.

d. Acceptable means of compliance for the provision, design and construction of wastewater infrastructure is contained within the Hamilton City Infrastructure Technical Specifications.

e. Wastewater collections networks shall be conventional gravity systems.

f. All wastewater shall be collected and disposed of in the public wastewater network. Retention and treatment of solids on -site (i.e. in septic tanks) is not permitted where a public wastewater network can be provided.

11.3 Water Supply and Demand Management

11.3.1 General

Residential premises will dominate the water demand within the Te Awa O Kātāpaki catchment. Undeveloped areas of the Te Awa O Kātāpaki catchment will be serviced by the existing water system. In future, the entire Te Awa O Kātāpaki catchment will be serviced within the Rototuna Reservoir Zone. Existing rural residential dwellings, however, will continue with their individual rain tank supply or trickle feed supply, until urban services are practically available for connection.

Notwithstanding the above, viable water sensitive options exist for a more sustainable and integrated approach and will need to be applied in accordance with provisions of the Hamilton District Plan.

In addition, Hamilton City Council has the following initiatives planned to ensure that water demand is met in the Te Awa O Kātāpaki catchment as well as other catchments within the city:

- City wide reticulation upgrades to support infill and intensification;
- Water demand and loss management programme to effectively manage water in the network and reduce loss;
- Continuation of the water model to forecast water demand out to 2061 and beyond;
- Enforcement of Water bylaw which requires water conservation in accordance with trigger levels;
- Education initiatives on water demand management;
- Reducing water demand through universal metering or meet increased growth demand through the construction of additional treatment capacity;
- Continue to work with Waipa and Waikato District Councils to provide a Sub-Regional solution to water as per the Sub-Regional 3 Waters Strategy;
- Implementation of Public Health Risk Management Plan (Water Safety Plan)

11.3.2 Best Management Practices

This section provides details of the water BMPs that have been selected to achieve the objectives for the catchment.

Best Management Practices are standardised citywide measures as described in the RITS and the HCC District Plan. Water supply infrastructure shall be designed and constructed to meet consumption, hygiene, water-sensitive design and firefighting requirements. Undeveloped areas of the catchment will be serviced by the existing water system. New distribution networks shall be compatible with the existing system in accordance with the RITS.

A list of suitable BMPs for water supply and conservation for the catchment has been developed. The BMPs listed below provide for specific requirements. For items not discussed in this Section, refer to the design requirements provided within the RITS.

Water BMP 1 – General Requirements

a. An adequate, reliable, safe, and efficient supply of potable water shall be provided.

b. Where any subdivision or development results in additional allotments or buildings to be used for urban purposes, provision shall be made for:

   i. Water metering infrastructure, and either
   ii. A connection from the public water supply reticulation to each proposed residential allotment or existing building, or
   iii. A public water supply reticulation system extending from the main trunk water supply system (or from an existing water supply reticulation if appropriate) to allow a service to be connected from the transport corridor frontage of each non-residential allotment.

c. A reticulation system shall be provided which is adequate for fire-fighting purposes and for estimated domestic and commercial consumption.

d. Evidence of satisfactory water supply shall be provided.

Water BMP 2 – Water Use Reduction

a. Low flow fixtures shall be incorporated into all new buildings within the catchment in accordance with the District Plan.

b. Where a stormwater re-use tank is installed, the tank shall include a permanent storage volume for use outdoors (i.e. watering gardens or washing cars) and toilet flushing and laundry by plumbing the tank into the house. The tank may be plumbed into the mains supplied potable water system via an approved backflow prevention device. See Hamilton City Council Three Waters Management Practice Note available online[35].

Water BMP 3 – Education

a. Education measures shall be applied to ensure that community are aware of operation and maintenance of alternative on -site water systems.

[35]http://www.hamilton.govt.nz/our-council/council-publications/manuals/Pages/Three-Waters-Management-Practice-Notes.aspx

11.4 Three Waters Mitigation Measures - Implementation

BPO assessment and selection is not always area specific. There may be cases where another option is more appropriate for the conditions such as contours and geotechnical nature of the site. If there is an option that is not listed in the ICMP that a developer wishes to propose, then the developer will be required to prove that this option is the most appropriate and will meet the listed strategic and operational objectives.

The outcome of a BPO process cannot be predetermined. Pre-determined outcomes or one type of solution should not always be used by default as this can lead to less suitable solutions being adopted. In a BPO process it is expected that the design engineer will apply suitable knowledge and judgement. Where constraints preclude the use of standard solutions or the BMPs in this ICMP then alternative systems utilising the BMP concepts can be proposed, with justification, for approval.

It is unlikely that practices used prior to stronger environmental policy will meet current objectives and the outcomes needed for the Te Awa O Kātāpaki catchment to maintain and protect its integrity. Important points are listed below:

- Unless specifically superseded by the requirements of this ICMP, all development design is to be in accordance with the RITS.
- Development proposals that do not consider the cumulative environmental impacts of development, and only propose practices that will manage these effects now but not in the future, are unlikely to be consented.

11.4.1 Planning and Design

Planning and design for development within the catchment shall be undertaken in accordance with the requirements of this ICMP. As part of the planning and design process it is expected that the suite of acceptable solutions will be considered and reported on for all developer led designs. The design report should include but not necessarily be limited to the following.

<u>Nature of Water Use and Discharges</u>
Describe the nature of water use and discharge in relation to:

- The quantity of runoff from the existing catchment and how this will change with development
- The quality of runoff from the existing catchment (using either information on contaminant concentrations and loads from the literature or from assessments/monitoring information, if available)
- Wastewater discharges considering special measures for re-use, reduction, or disposal
- Water use considering measures to reduce consumption

Use the above information to predict the contaminant loads that are likely to be generated from the catchments under the proposed development scenarios.

<u>Stormwater Mitigation Measures – Stream Protection</u>

Describe the measures and stormwater management options that were considered to achieve the objectives set for the catchment and to mitigate the impacts of stormwater runoff on the receiving environment. This includes cumulative effects on existing and future development.

A description of how these options and measures were evaluated should also be included along with details on how these measures will be implemented. This might include riparian margin work, fencing, bank stabilization, hydrological controls, and water sensitive techniques.

Stormwater Mitigation Measures – Contaminant Management
Describe treatment device options, and/or water sensitive techniques considered, in a similar manner as above.

Water Demand and Discharge Measures (Water and Wastewater)
Describe the measures and options that were considered to achieve the objectives set for the catchment and to minimise water use and discharge. This includes cumulative effects on existing and future development.

Three Waters Integration
Describe how the measures considered can be integrated for overall effect and efficiency.

Option Evaluation
Summarise the mitigation measures considered to achieve each operational objective. The process carried out to evaluate these measures should be described and the reasons provided why certain measures were selected or discounted.

Infrastructure Plans
Provide network service plans which have been developed to address network requirements. Describe the key aspects of 3 waters network management including:

- Staging
- Alignment with growth and impacts on HCC's existing key infrastructure (e.g.) treatment plans, trunk lines etc.
- Proposed key infrastructure

11.4.2 Timeframe

Most of the mitigation measures set out in this ICMP and selected in the planning and design process will be required to be implemented as development comes forward and when subdivision consents are applied for. Council may elect to install major infrastructure in advance of private development in some cases.

Refer to Section 11.5 for the proposed timing of major infrastructure required for the catchment.

11.4.3 Mechanisms for Implementing Measures

The District Plan and relevant Structure Plan seek to control the effects of subdivision, development and use of land on the environment. The Hamilton City Council RITS provides the technical guidelines which developers must adhere to. Together with this ICMP they provide the legislative context for development to follow and are vital tools in managing the development within the catchment.

Mechanisms for implementing measures include:

- **Development applications** – Development applications will be assessed against each of these documents for compliance which can ultimately influence if the development can proceed or not. Consent conditions will be written and enforce accordingly.
- **Stormwater Bylaw** – Council are in the process of drafting a stormwater bylaw which will set out Councils powers under the Local Government Act to manage, regulate and protect, and to prevent the misuse of Council's land, structures or infrastructure associated with stormwater drainage.
- **Councils Long Term Plan** – The LTP is used as a funding mechanism for infrastructure required for the catchment. Funding requirements shall be considered and fed into the LTP process.
- Passive **implementation** through existing programmes such as:
    - Planned maintenance and operational improvements
    - Asset renewal programmes
    - Design and development in accordance with RITS
    - Customer service level (satisfaction, complaints).

11.4.4 Changes in Application of BMPs

HCC will monitor designs and construction as development progresses. Where approved designs or as built construction changes the outcome, the application of BMPs or the nature of the BMPs in the ICMP may need to be changed.

A reduction in requirements will not be made for minor improvements against the objectives. For a fundamental change to the ICMP objectives to be made, the positive impact of actual development will need to be significant and measurable. The same approach will generally apply to the application of more stringent requirements, but it is acknowledged that adverse effects and degradation can be a slow process. A more proactive approach will be undertaken where a minor but statistically significant reduction in quality is measured over time.

Developers should be aware that changes may mean that different BMPs will be required. These could differ from those already implemented by earlier developments in the catchment. Changes will only generally be made if a more practicable option is identified, usually at a cost benefit. The exception to this is where implementation results in the identification of an environmental shortcoming which requires a more stringent BMP.

11.5 Major Infrastructure Requirements

This section outlines the major infrastructure required to service the catchment. If not already implemented by HCC, developers shall discuss major infrastructure requirement in relation to proposed staging. Developers will be responsible for constructing major infrastructure described below within the development area.

11.5.1 Water

The location and size of strategic infrastructure is confirmed by HCC via the HCC Water Master Plan. The Rototuna supply reservoir, 550mm diameter bulk water pipeline along Resolution Drive to the reservoir and the 700 mm bulk water pipeline along Resolution Drive from the reservoir are now in place.

The implementation of 250 mm diameter trunk water pipelines within development areas will be required.
The new strategic infrastructure (reservoir and bulk pipelines) will initially operate as a push pull reservoir system the same as others within the city. Eventually the bulk mains will be segregated with one to fill the reservoir and the other to service the catchment from the reservoir. Supply zone boundaries are also under development.

The location of proposed 250mm trunk pipelines is to be confirmed. Developers shall seek advice from HCC for the purpose of planning and incorporating the pipelines into development plans.

Refer to Appendix C for plans showing major infrastructure planned but not yet constructed and their location in relation to existing major water infrastructure.

11.5.2 Wastewater

There are no specific requirements due to the level of existing planning and implementation. Refer to Appendix C for plans showing key developer infrastructure planned for but not yet constructed.

11.5.3 Stormwater

Remaining undeveloped or developing areas within the catchment is defined by sub-catchments shown in Plan 003 in Appendix A as follows:

- Upper West
- Upper East
- Expressway West
- Expressway East
- Hamilton Section of the Waikato Expressway
- Rototuna Town Centre
- Resolution

Refer to Plan 012 in Appendix C and to Appendix F for indicative locations and design requirements for specific development sub-catchments.

<u>Upper West - Bourn Brook swale</u>
A swale is now constructed adjacent to the Rototuna Town Centre. The swale is designed to service the needs of the Upper West sub-catchment. The swale is designed to carry out the following:

- Extended detention
- Attenuation up to the 10-year ARI storm event
- Swale sufficient to convey a 100-year ARI event

This swale is now constructed and is known as Bourne Brook Swale and does not meet current stormwater treatment requirements and will be supported by offline water quality measures.

<u>Expressway West</u>

This catchment will interact with the Bourn Brook swale. Stormwater wetlands are proposed to service this area in conjunction with the swale. The wetlands will provide treatment and extended detention. In conjunction with the swale, attenuation and flood conveyance will be provided.

It is essential that the wetlands are designed and constructed accordingly because their absence would adversely affect the overall operation of the swale. A culvert sized to convey 100-year ARI flows will be required under the Expressway.

Provided the design is finalised as above, within this sub-catchment additional stormwater devices are only required to satisfy on-lot requirements.

Expressway East

This catchment is north of the proposed Expressway. A complex of several wetlands is proposed to service various developments within the area. The wetlands will need to provide treatment and extended detention, and attenuation (including 80% of predevelopment for the 100-year ARI) and will discharge to the Kirkdale Conveyance Pipeline and the Borman Road Stormwater Pipeline.

Primary and secondary flow paths to Borman Road will be required through the Upper East area. A culvert to convey attenuated 100-year ARI flows has been constructed under the Expressway. A buried section of pipe was also constructed as part of the Expressway works for the purpose of providing a primary system connection through the Expressway corridor.

Provided the design is finalised as above, within this sub-catchment additional stormwater devices are only required to satisfy on-lot requirements.

Upper East

This area is south of the proposed expressway. A complex of several wetlands is proposed to service various developments within the area. The wetlands will need to provide treatment and extended detention, and attenuation (including 80% of predevelopment for the 100-year ARI) and will discharge to the Borman Road stormwater pipeline.

A conveyance system will be required to convey developed primary and secondary flows from the Expressway East and Expressway catchments through to the Borman Road stormwater pipeline. Secondary (100-year ARI) MPD catchment flows from the Expressway East will be attenuated to 80% of pre-development conditions, however runoff from the Expressway will only be attenuated up to a 50y ARI event. The conveyance infrastructure will need to be designed to cater for these flows.

The Upper East catchment conveyance infrastructure is currently indicated on Plan 012 as a pipeline. The current farm drains in this area have all been assessed as artificial watercourses so are not necessarily required to be restored. However, the design of this element will need to be formalized at the time of sub-division based on site-specific investigations (e.g. aquatic ecology of the local drains) and ensuring that the hydrology of the upstream freshwater wetland (refer Section 3.5.3) is maintained.

A future project opportunity has been included in HCC's city-wide database to look at daylighting the Borman Road pipeline and creating an open channel watercourse for the eastern portion of the Upper Catchment.

Provided designs are finalised as above, within this sub-catchment additional stormwater devices are only required to satisfy on-lot requirements.

Expressway (The Hamilton Section of the Waikato Expressway)

The western part of the Hamilton Section of the Waikato expressway (due for completion in 2022) will discharge to the Rototuna Town Centre Swale. The eastern part of the expressway will discharge to the Kirkdale Conveyance System and the Borman Road Stormwater Pipeline. The expressway will treat and attenuate all runoff from within the road designation, prior to discharge to the Rototuna system.

Although designed as a standalone system, the expressway will be required to meet the objectives of this this ICMP. Discharges from the expressway have been accounted for in modelling and assessment of the receiving network.

Rototuna Town Centre

This catchment is south of the proposed Rototuna Town Centre Swale. It is not in a location which can be serviced by the swale, so a wetland is proposed to service this catchment. The wetland will need to provide treatment and extended detention, and attenuation and will discharge to the Borman Road – Resolution Drive culvert and the Tuirangi Floodway at the downstream end of the Town Centre Conveyance channel.

Provided the design is finalised as above, within this sub-catchment additional stormwater devices are only required to satisfy on-lot requirements.

Resolution

This area consists of the future Resolution Drive extension and two small areas of private development to the west. Each development will provide its own wetland solution prior to discharge the HCC Stormwater network and the Tuirangi Floodway. The wetlands will need to provide treatment and extended detention, and attenuation.

Provided the design is finalised as above, within this sub-catchment additional stormwater devices are only required to satisfy on-lot requirements.

Tuirangi Floodway

No work to modify the operation of the Tuirangi Floodway (e.g. attenuation weirs) is proposed to occur in the section of the stream upstream of Magellan Lake. This approach is consistent with current best practice to avoid the construction of structure in the bed of named or ecologically valuable watercourses. This does not preclude works to repair or improve the condition of the stream which would be carried out as needed and in consultation with Waikato Regional Council and other stakeholders such as iwi.

Flood levels are predicted to be at the allowable limit in some sections of the main floodway which precludes structures or changes that could increase flood levels. The floodway will continue to operate and maintain flood extents as they are now.

Refer to Appendix C for plans showing major infrastructure planned but yet to be constructed and their location in relation to existing major stormwater infrastructure.

Magellan Lake

Magellan Lake is located downstream of the Tuirangi Floodway between Magellan Rise and The Link (Figure 30). The lake was built by a developer to deal with stormwater runoff from roads, houses, and driveways associated with urban development around the lake. The lake was designed to control stormwater to prevent issues such as flooding and pollution.

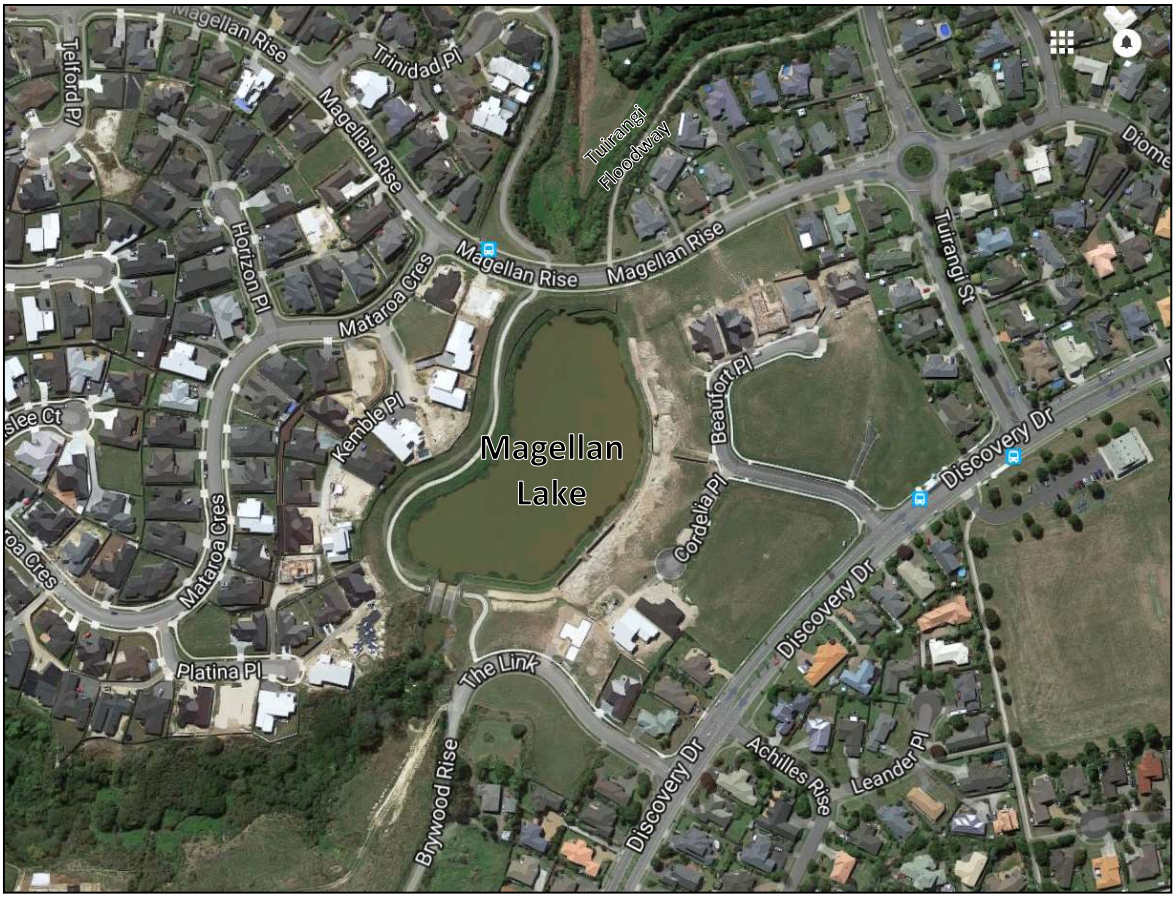


Figure 30 – Magellan Lake

Technology and best practice for urban flood control and pollution control has changed since Magellan Lake was built. The design and operation of the lake is not ideal based on today's practices as follows:

1. The lake is too deep for plants to grow well; plants are important to help clean stormwater.
2. Clean water from other areas flows into the lake and gets mixed with dirty water in the Lake.
3. Slow moving water in the exposed lake gets warmed by the sun and has low amounts of oxygen which is not ideal for native fish and eels.

Although the lake is considered compliant at the time of writing this plan the Lake may not meet the standards for managing stormwater in the future. In the long term, potential improvements could include modifying the lake to a wetland design. See Appendix H for details.

11.5.4 Magellan Lake

Magellan Lake is an on-line stormwater treatment device located between Magellan Rise and The Link in Rototuna. The lake is used to attenuate flows from existing and proposed residential subdivisions. The lake outlet includes a low flow spillway and fish pass enhanced with hand placed rock to provide low velocity areas for swimming fish species.

Hamilton City Council has investigated potential to modify Magellan Lake to enhance its contribution to water quality and attenuation objectives while enhancing amenity. Three key reports are:

- Magellan Lake Optimisation Investigation Phase 1 (2016), Tonkin & Taylor Ltd (T+T).
- Phase 1 Report Addendum (2016), T+T.
- Magellan Lake Optimisation Investigation Phase 2 Report (2017), T+T.

A list of other relevant reports is provided in the Phase 1 report.

General description

Magellan Lake was designed sometime between 2004 and 2009 as an online stormwater detention pond as part of a subdivision by CDL Land New Zealand Ltd (CDL). The lake was consented under the Resource Management Act around 2008 and was constructed in 2009/2010.

Design and consenting of the Lake was led by McPherson Goodwin Surveyors Ltd (MGSL). Geotechnical design was provided by Mark T Mitchell Ltd (MTM). Hydraulic capacity, environmental and ecological assessments were provided by T+T. Construction work was undertaken by HEB Construction Ltd (HEB).

Magellan Lake was constructed by excavating to shape and depth and constructing a weir across the Te Awa O Kātāpaki Stream. The weir height and volume of water stored means that the weir is defined as a 'large dam' and therefore falls under the requirements of the New Zealand Building Code.

Consenting history

CDL obtained several resource consents from Waikato Regional Council (WRC) relating to a proposed subdivision and development of the lake. Consents have been transferred to HCC and include:

Table 11-1 – Magellan Lake consents and permits

No.	Description	Consent holder	Duration / expiry
113670	For land disturbance (vegetation clearance and earthworks) activities to create the Lake	N/A	Expired
113673	Water permit to dam and divert TAOK stream	CDL	20 years to 23/12/2028
113674	Discharge permit to discharge urban stormwater from the 74-hectare CDL development to Magellan Lake and the TAOK stream (Note: this consent is likely to be held separate to the citywide comprehensive stormwater discharge consent)	CDL	20 years to 23/12/2028
115069	Water permit – diversion to construct, use and maintain an 1800 mm diameter stormwater pipe. This pipe enters the stilling basin associated with the Lake weir outlet	CDL	35 years to 23/12/2043
137134	Certificate of Acceptance - Dam and/or Appurtenant Structure, Section 99, Building Act 2004	HCC	Not applicable

Hamilton City Council holds a permit (Resource Consent No. 105279) to discharge urban stormwater from various areas to various discharge points within city boundary including the Te Awa O Kātāpaki Stream; commonly referred to as the Comprehensive Stormwater Discharge Consent (CSDC).

There are no specific stormwater quantity control (e.g. attenuation) criteria in the consent conditions. Reference to the application documentation is made in which the requirements are documented.

Lake compliance

WRC provided a letter to the HCC (dated 7 March 2016) setting out its review of compliance with the various consent conditions associated with the Lake. WRC concluded that the consent holder is in full compliance with all consent conditions.

WRC noted issues with dissolved oxygen and pest fish but considered these were long term issues associated with Resource Consent 113674. It is likely that Resource Consent 113674 would be surrendered under the CSDC with all other consents being held individually by HCC. Enhancement works were proposed; however, HCC has been unable to secure funding or community support for this.

11.5.5 River Road Reach of the Te Awa O Kātāpaki Stream

The stream reach downstream of the existing River Road Culvert has been identified as a key erosion area in this ICMP. Erosion has been developing at the location for some time and has caused issues with private properties which extend to the historic stream centerline.

Minor stabilisation works were undertaken as part of the River Road Culvert upgrade in 2013. The 2013 works were not intended to be the final works undertaken at the site. In the period since 2013 a number of assessments have been undertaken to understand the mechanism of erosion and potential solutions.

In 2019 subsequent major stabilisation works were undertaken by HCC in partnership with Project Watershed. This involved battering and planting of stream banks, grade control structures and bank armoring. **Error! Reference source not found.** shows a section of the completed works. Some residual erosion issues remain around the stream outlet. A meeting was held with WRC in 2022 in which it was agreed that remining issues are river-related.

11.5.6 Physical Works Programme

This section outlines the key infrastructure or mitigation measures to be applied to address identified issues.

Existing Device Improvements

The table below summarises recommended existing device upgrades and has been put forward for consideration for LTP funding. Works may also be completed through operational funding streams, which is implemented through regular meetings with business owners.

Table 11-2 - Existing Stormwater Devices Issues and Mitigations

Issue/Opportunity	Issue Priority Score	Proposed Mitigation	Complies with current requirements	Total Cost
Lake Magellan Deep online pond with no aquatic vegetation or flow control. Turbid water and likely risk of future algal blooms. Surrounded by houses with high use path but degraded amenity due to condition.	High	Convert into functional wetland with bypass, reduced depth through infilling, vegetation and maintainable forebays	No	$1,800,000
Lansdale/Waireka 1 Good design except for being online and non-compliant outlet structure. Very good access to forebay with markers for operator. Poor access to inlet/outlet for inspection but easily fixed with path. Very good vegetation cover.	High	Make stable pedestrian path to inlet and outlet	Yes	$10,000
Choy HC/Waireka 2 Good design other than. (a) no high-flow bypass with risk of increased velocities once catchment fully developed, (b) outlet structure at surface without submerged connection with potential for blockage. Lack of vegetation on immediate perimeter may be result of species selection.	High	Plant perimeter with suitable shallow marsh species. Not considered realistic to retrofit bypass pipe or compliant outlet structure	Yes	$2,000

Table 11-2 - Existing Stormwater Devices Issues and Mitigations				
Petersburg #1 Wetland appears well sited but has not been maintained with no access to inlet, substantial weed ingress and disconnect from community.	High	Clear existing access to forebay/inlet, thin dense vegetation at Te Huia Drive end to improve visual connection, clear accumulated sediments (will require full reset), remove establishing willows, improve accessibility to outlet.	No	$150,000
Kimbrae Tight site with relatively steep (deep) batters. Access provided to inlet with banded bathymetry. Densely covered (planted?) with Typha which is not good for treatment. Understood to be unlined but appears to be holding water. Outlet structure non-compliant and poor quality with exposed and vulnerable pvc pipe and difficult access for inspection/cleanout if blocked	High	Plant batters with appropriate species. Review outlet design and provide formal access.	Yes	$15,000
Northridge Large new wetland sized for additional development in catchment (to come). Uncertain hydraulics with inlet submerged and hard to inspect. Apparently has partial high-flow bypass which discharges back into wetland in mid reach. Outlet structure non-compliant. Planted with Typha which should be avoided. Includes some riparian habitat features (wood stacks) but small size and likely to rot quickly.	High	Determine hydraulic configuration and ensure alignment of inlet pipe is clearly marked for Ops. Remove Typha and re plant with appropriate species. Infill plant elsewhere with more diverse species.	Yes	$30,000
Te Huia Contemporary walled wetland designed with banded bathymetry, online to all flows. Wetland designed as lined but currently not retaining water resulting in exposed soils, weed growth and expected reduced treatment. Outlet structure accessible but non-compliant. Some residual risk from edge walls.	Medium	Investigate source of leakage (could be related to perforations or interface with perimeter wall). Determine scale of works to repair and reinstate wetland.	Yes	$200,000

Table 11-2 - Existing Stormwater Devices Issues and Mitigations				
St James #3 Linear online system with 3/4 cells separated by gabion bunds. Forebay and inlet currently hard to access with vehicles but relatively easy to remedy. Variable depths with current short circuiting. Portion of failed gabion.	Medium	Improve access to inlet/forebay to support truck movement. Improve levels of gabions and infill plant. Potential to create high flow bypass (partial) but could be difficult. Good opportunity to link with improved public access	No	$150,000
St James #1 Tight site below road with limited public access. Online with flows forming preferential flow path over gabion bunds. Good riparian planting with semi mature Kahikatea	Medium	Improve hydraulic control (Gabions) and forebay, increased potential for public access and with improvement to vehicle access. Potential for partial high flow bypass	No	$80,000
Trauzer Construct forebay, segregation bund and sectioning into shallow wetland etc and plant. Enhance roadside riparian	Medium	Construct forebay, segregation bund and sectioning into shallow wetland etc and plant. Enhance roadside riparian	No	$125,000
Moonlight Access at inlet end. Enhance roadside riparian	Medium	Access at inlet end. Enhance roadside riparian	No	$25,000
Borman Access at inlet end. Enhance roadside riparian	Medium	Access at inlet end. Enhance roadside riparian	No	$10,000

Table 11-2 - Existing Stormwater Devices Issues and Mitigations				
Woodridge Construct forebay and clean out, dig out outlet area and form control outlet, add rocks and plant as a stream.	Low	Construct forebay and clean out, dig out outlet area and form control outlet, add rocks and plant as a stream	No	$35,000
Tennille Street Provides good amenity in tight urban location but treatment limited by online configuration and challenges with maintenance. Access to the outlet (located in middle) is difficult and clean out of inlets likely difficult. Appears to be groundwater fed with very clear water at time of inspection.	Low	Infill plant now established and formalise safe access to outlet.	Yes	$10,000
Hector Access track to forebay and infill planting. Improve perimeter planting.	Low	Access track to forebay and infill planting. Improve perimeter planting	Yes	$25,000
Delia Court Appears to be reasonably well designed but offline and with difficult to access outlet structures. Currently in poor condition with weed growth (willows) and expanses of open water (likely a result of excess depth, turbidity and lack of planting). Large areas of rock protection (reno mattress) reduce amenity and appear excessive for the frequency of engagement for spillways etc. Significant apparent cross connection issue with evidence of long-term grey water inflows	Low	Investigate and fix greywater/blackwater inputs. Clean out forebay. Maintain vegetation including removal of large willows. Import soils to shallow depth of pools and plant with appropriate species. Where feasible wash topsoil into exposed reno mattresses and plant/seed. Improve access to hydraulic structures.	No	$100,000

Table 11-2 - Existing Stormwater Devices Issues and Mitigations				
Bourn Brook Swale Online pond (not swale as described) with three large inlet pipes and number of small side entries along route. No access to inlet (forebay?) for machinery or foot. V difficult to provide safe vehicle access. Appears deep with very little planting in main channel. Fully online with high length to width ratio and v limited scope to retrofit bypass. Outlet inaccessible and overgrown	Low	Construct formal pedestrian path to inlet and outlet for inspection/manual clear-out. Not practical to convert into wetland due to online and narrow form. Considered unsuited to provide water quality treatment for further development.	No	$30,000
St James #2 Inaccessible online site below road with no access. Did not inspect outlet due to access	Low	High cost to provide access with v limited benefits.	No	$150,000
Nicks Way Wetland located in very tight location, online and with vertical drop from inlet to main body which is hard to access being surrounded by private property. Easy access to excavator bench for cleanout at inlet but v hard to reach lower wetland cells. Outlet appears to have been modified to lower standing water level.	Low	Clean out inlet/forebay. Assess for existing scour in drop to wetland, reinstate outlet structure, control weeds and replant	No	$50,000
Total:				**$2,997,000**

Other recommended works programmes and associated funding status are summarized in Table 15-2 (Programme of Works).

12 Design Parameters and Means of Compliance

Design parameters presented are those that are required to protect the receiving environment. The Means of Compliance table lists the prescribed solutions to meet design parameters for new development within the Te Awa O Kātāpaki Catchment with appropriate design. It should be noted that over 70% of the catchment is developed and up to 90% of the catchment has been consented for development. Alongside new development, opportunities exist for improvement or retrofit to existing devices and the requirements of this ICMP will apply to any remaining new development or re-development within the catchment over time. It is important to note that these requirements shall be implemented unless specific resource consent conditions require an alternative solution.

12.1 Implementation methods[36]

Mitigation measures set out in this ICMP are collated in the MOC table and expected to be implemented as subdivision proceeds and as individual lot development progresses (i.e. building consents).

In some cases, Council may elect to install major infrastructure. Funding decisions of Council are made via the Long-Term Plan process in accordance with the LGA which is informed by Councils 30 Year Infrastructure Plan and planning documents (e.g. District Plan, Hamilton Urban Growth Strategy). These are collated in the Programme of Works Table 14-1.

The BPOs and BMPs identified in Sections 7 to 11 have been translated into a range of actions, projects and compliance requirements that is given in:

- Design Parameters (Table 12-1)
- Means of Compliance (Table 12-2)
- Programme of Works (Table 14-1)
- Future Actions and opportunities (Table 15-2)

12.2 Design Parameters

Error! Reference source not found. summarises what is required to comply with the catchment objectives where multiple BMP solutions exist. Reference to the objectives should still be made for aspects which are common to all areas, or those that are to be assessed and mitigated in relation to a specific area. These could include, but are not limited to:

- Erosion and stability mitigation and protection
- Overland flow paths and flood mitigation
- Environmental and ecological considerations (i.e. habitat, fish passage, riparian planting)
- Location of strategic infrastructure (refer to Appendix C)
- Construction controls
- Compliance
- Education

[36] CSDC / Condition 30(k)

Table 12-1 – Te Awa O Kātāpaki/River North ICMP Stormwater Design Parameters

Parameter	Catchment Requirement
All sub-catchments (including River North)	
On lot	Provide retention of at least 10mm runoff depth on the new and redeveloped impermeable surfaces. The retention is to be provided through a combination of rainwater capture appropriately connected to the building for non-potable reuse, and infiltration via targeted soakage within the lot boundary. If infiltration is not achievable, due to poor infiltration rates, groundwater levels or site conditions, this component of the required retention volume can be replaced by on-site stormwater quality treatment as follows: • Provide quality treatment for the Water Quality Volume (WQV) from new and redeveloped impermeable surfaces prior to discharge. At-source retention is required to be maximised. In some cases, treatment of the WQV may be able to be achieved in a downstream device.
On lot (high risk sites)	A **Pollution Control Plan** and on-lot contaminant source control and treatment. M,
Gross Pollutants	Gross pollutant removal required as part of device design
Water Quality	Contaminant removal that complies with RITS and the most up to date version of WRC's Waikato Stormwater Management Guideline.
Temperature	< 23 degrees Celsius and a waterway increase of no more than 3 degrees
Network design (All Waters)	To RITS standards (unless specified otherwise within this ICMP) and sized to service the fully developed catchment to achieve minimum levels of service. This includes overland flow paths.
Volume	Retain a minimum of the initial abstraction volume on average across the site. Match pre-development runoff volume through reduced runoff practices & sub catchment management. If this cannot be achieved, mitigation within the receiving environment will be required such as channel stabilisation.
Environmental Enhancement[37]	Retain and existing waterways and enhance with riparian planting of a scale to support biodiversity and improve cultural, ecological, and biological health of the catchment.

[37] Enhancement is where resource use and activity provide a net benefit back to the environment and to social, spiritual, cultural, and economic aspirations, and the quality of the environment is improved for future generations.

Parameter	Catchment Requirement
Outlets to waterways and the Waikato River	To be designed and constructed in accordance with the RITS.
Groundwater	Prior to construction of sub-catchment stormwater devices, groundwater (depth) monitoring at the location of each stormwater device is required from a groundwater monitoring well. For devices with an impermeable (lined) layer, a minimum of monthly readings over July - November is required. For devices with a permeable (unlined) layer, a minimum of monthly readings for a 12-month period is required. If the year is unseasonably wet or dry, then the monitoring should be repeated for another complete cycle.
Freeboard	Flooding freeboards (as defined by the Operative District Plan) shall be provided above 100-year maximum probable development mitigated flood levels.
All catchments discharging to a gully or watercourse	
Extended detention	As per RITS
Expressway, Upper and Southern catchments	
Stormwater attenuation	2-year and 10-year pre development
Expressway East and Upper Catchment East sub-catchments (and the associated eastern end of the Waikato Expressway)	
Stormwater attenuation	2-year and 10-year pre-development
Flood attenuation	80 % of the 100-year pre development

12.3 Means of Compliance

The following table provides the best management practice and some design detail specific to sub-catchments that will meet Te Awa O Kātāpaki catchment objectives.

Table 12-2 – Means of Compliance with ICMP Objectives

Requirement	Reason
Stormwater – all sub-catchments	
Standard requirements for all Lots include • No exposed zinc or copper building products. • High Contaminant Load areas to drain to stormwater pre-treatment device (e.g. swale etc.) prior to leaving site. • Catchpits designed for capture of gross pollutants (as per RITS). • For non-residential land uses, retain a minimum of the initial abstraction volume on average across the site for new impervious areas to be achieved through re-use or soakage. Refer to HCC 3W Practice Note 1 for additional guidance.	

Requirement	Reason
• For residential land uses, the 10mm retention volume should be achieved through a rainwater reuse tank plumbed into the dwelling for non-potable uses, which overflows to an on-lot soakage device which also receives run off from impermeable surfaces. Refer HCC 3W Practice Note 1 for additional guidance.	
On-lot soakage per the requirements of BMP 2 and the RITS. Testing shall as a minimum determine the shallow soakage potential and the water table depth. In Profile D areas, soakage potential shall be assessed below the overlying loam layer (refer to Figure 3 in Appendix D). Where soil permeability allows, stormwater attenuation (2y, 10y ARI) is to be achieved through soakage.	Groundwater recharge and volume reduction to maintain pre development runoff character, where practical.
Where feasible, centralised treatment devices servicing sub-catchments, as identified on Plan 012 in Appendix C. Devices are to be located and sized to ensure design flows are captured, managed, and operated and maintenance costs are kept to a practical minimum. Devices are to be consolidated where reasonably possible. These may be shifted slightly or have layouts revised from the locations shown in the ICMP but will generally not be split or have substantial changes to catchment delineation unless it can be demonstrated that these are necessary. In most cases, stormwater devices will cater for multiple developments. Treatment to be in compliance with the Design Parameters table.	Minimise number of devices for operation and maintenance purposes.
Device type – preference for centralised wetland of RITS design (selection and design in accordance with RITS).	Contaminant removal (all), extended detention and attenuation for environmental, erosion and stability for the areas as specified in the above table. Flood control if required.
All infrastructure sizing, locations and alignments are concept or preliminary and shall be confirmed by detailed design and integrated with other infrastructure (e.g. roads, wastewater pump stations) to implement the solutions and meet the requirements of the ICMP.	
Secondary flow path for 100-year ARI event in road or reserve and secured by an appropriate legal mechanism to the satisfaction of HCC. Adequate freeboard to be provided to all buildings.	Flood control.
Lots with **High Risk activities** require a **Pollution Control Plan** and site-specific on-lot source control and treatment design.	
<u>Ecology report</u> There are eight areas that have been classified as possible natural wetlands in the Upper Catchment.	To assess the effects of development against the provisions of the National Environmental Standards for Freshwater Regulations 2020 (NES-F).

Requirement	Reason
Where works are proposed within a possible natural wetland, stream or gully an ecologist's report shall be provided.	To demonstrate that ecological values and or risks are sufficiently low to permit the works. This includes consideration of, but not limited to, habitat, groundwater seeps, springs, effects on vegetation (note this is not the sole test for allowing works within these areas).
Geotechnical report Where works are proposed within a stream, gully or within the District Plan specified setback an engineer's report shall be provided.	To demonstrate that stability and associated geotechnical risks are sufficiently low to permit the works (note this is not the sole test for allowing works within these areas).
Developers and Key Stakeholders shall work together and collaborate with Hamilton City Council to effectively implement the Te Awa o Kātāpaki ICMP to implement the solutions and meet the requirements of the ICMP.	
Stormwater – Upper West Catchment (Map 003)	
The south western parts of the upper west catchment that drain to Bourn Brook Swale will require treatment of roading corridors. On-lot requires a water efficiency measure that targets water quality improvement (e.g. rain water re-use)	Water quality treatment
Stormwater – Upper Catchment East	
The conveyance infrastructure from Wetland E1 to the Borman Road pipeline shall, as a minimum, be designed to carry the 100 year MPD from the contributing catchment including the Waikato Expressway.	Flood control
Stormwater – River North	
River Road urbanisation River Road is located on the boundary of the River North and Southern Catchment, provided future road stormwater discharges direct to the Waikato River, extended detention, volume control, and attenuation is not required.	Direct discharge to the Waikato River does not require extended detention or attenuation.
Individual property discharges Soakage is the preferred method of disposal. If soakage is not feasible then on-lot management in accordance with HCC three waters practice note HCC01 is required. Extended detention, volume control and treatment are required for properties discharging into gullies or watercourses.	Private system to comply with the treatment and attenuation requirements of the relevant sub-catchment (River North or Lower).
Stormwater – Resolution Drive	
Reference shall also be made to the Resolution Drive sub-catchment ICMP (D-1643828).	The sub-catchment ICMP provides additional information and options relevant to development in the sub-catchment.

Solution / requirement	Reason
Wastewater – all sub-catchments	
Levels of service are to be achieved in accordance with RITS requirements. The collection network and associated pump stations shall be designed to service all upstream flows (existing and planned)	To achieve minimum levels of service.
Best practice design, construction and inspection are required to ensure that inflow and infiltration is minimised.	To achieve minimum levels of service.
Wastewater – Upper East catchment	
Moonlight pump station requires emergency storage for ultimate development. The upstream network has not yet been designed and may accommodate some or all of this requirement.	To achieve the RITS requirement for emergency storage.
Wastewater – River North	
Within the hatched area on Plan 011 single lot development or subdivision of existing lots shall comply with WRC requirements for on-site wastewater disposal (>2500m^2 gross area).	To achieve compliance with on-site wastewater discharge requirements until HCC establishes a public wastewater pipeline to service the area (2022).
Wastewater – Resolution Drive	
Reference shall also be made to the Resolution Drive sub-catchment ICMP	The sub-catchment ICMP provides additional information and options relevant to development in the sub-catchment.

Solution / requirement	Reason
Water – all sub-catchments	
Levels of service are to be achieved in accordance with HCC's RITS requirements.	To achieve minimum levels of service.
Minimum pressure and flows to be achieved, including consideration of adverse effects on the existing built and consented environment.	To achieve minimum levels of service.
Water – Resolution Drive	
Reference shall also be made to the Resolution Drive sub-catchment ICMP.	The sub-catchment ICMP provides additional information and options relevant to development in the sub-catchment.

Where it can be proven that none of the methods listed above, or in the RITS, are practical for a given site, developers shall identify and discuss alternative solutions with HCC prior to design and submission for approval. The design of agreed solutions shall achieve the specified discharge requirements.

13 Assessment of Environmental Effects

The conditions for the CSDC provided by Waikato Regional Council requires that the ICMP include an assessment of the potential effects on the Te Awa O Kātāpaki catchment and receiving environment. An assessment has been undertaken considering the impacts 'after' the BPO measures are implemented and considers the following effects:

- Impact on Cultural & historical values;
- Public health and safety;
- Stormwater Quantity;
- Flooding hazards;
- Stream base flow;
- Stormwater Quality;
- Effects of Urban Development on Streams;
- Ecology (including in-stream and riparian);
- Aesthetics; and
- Effect on existing infrastructure.

This Assessment of Environmental Effects ("AEE") assesses the effects on the Te Awa O Kātāpaki Stream Catchment ("the Catchment") of proposed new stormwater diversion and discharge activities undertaken in accordance with the Te Awa O Kātāpaki Integrated Catchment Management Plan ("the ICMP").

The Catchment lies within Hamilton City east of the Waikato River. Former land use within the Catchment was mainly dairy farming and pasture grazing but the catchment is now about 80 % developed with another 10 % (estimated) in planning and design.

The undeveloped portion of the catchment is highly modified and there is very little riparian vegetation. Development already undertaken in the Northern Catchment has seen an increase in riparian and wetland planting in association with treatment and conveyance channels and wetlands.

The ICMP is a comprehensive plan for managing the three waters (stormwater, water supply, and wastewater) and its infrastructure within the Te Awa O Kātāpaki Catchment in an integrated way. It identifies Best Practicable Options, Management Practices, Means of Compliance, Future Actions and a Monitoring Programme. It aims to avoid as far as practicable, and otherwise minimise, the cumulative adverse effects of all new stormwater diversion and discharge activities within the Catchment.

This AEE is intended to satisfy the requirements of conditions 30(g) and 30(h) of Hamilton City Council's Comprehensive Stormwater Discharge Consent. It is based on assessments undertaken by environmental specialists including Morphum Environmental Limited and Boffa Miskell Limited.

The assessment concludes that any adverse effects of new stormwater diversion and discharge activities undertaken in accordance with the ICMP will be no more than minor. Implementation of the ICMP is expected to have positive effects on the Catchment, including the provision of wetlands with 80 %

vegetation cover, the provision of riparian planting and a reduction in farm runoff contaminants (e.g. sediment [post construction] and faecal coliforms).

A high-level assessment of the draft plan against the CSDC conditions is shown in Table 13-1. This assessment has been carried to ensure that appropriate BPOs have been considered.

13.1 Cultural & Historical Values

A previous cultural impact assessment (NAMTOK 2005) illustrates a rich and extensive pre-European history in the catchment and surrounding environs, including the gully system. Development in the catchment provides an ideal opportunity to enhance the gully system through enhancement and restoration, as well as providing public access. Importantly there is a high likelihood wāhi tapu and taonga could be discovered as the area develops (particularly along the banks of the Awa and the gully networks).

Restoration will help protect the health and mauri of the catchment waterways and the Kaitiaki relationship of tangata whenua with waterways.

The District Plan notes a number of known cultural sites within the ICMP catchment area (Te Tōtara Papakāinga, Owhanga Pā and numerous borrow sites).

Council has engaged with mana whenua during the development of this ICMP (Ngaati Wairere, and mana whenua collective represented by Te Haa o te Whenua o Kirikiriroa).

In response to the wetland and watercourse classification carried out by Tonkin & Taylor, Mana whenua are very interested in the ability for historic/indicative remnant wetlands to be restored through consenting (a current requirement under the new National Policy Statement for Freshwater Management when resource consents are assessed in these areas).

Council's Stormwater Requirements webviewer is of **high interest to mana whenua**, and it aims to capture a range of historic and recent assessments (from HCC or from other sources) to create a 'live' version of the truth for managing data, projects, and opportunities related to 3 waters across the City.

Mana whenua are interested in utilising this tool for a number of reasons, including:

a. Supporting their engagements with Council and developers in relation to land development, Milton noted that mana whenua don't have access to current data/assessments
b. Registering known sites of significance (work is underway with council and mana whenua to capture this digitally).
c. Capturing 'lesser known smaller sites' in a 'non-public' layer that Council staff and mana whenua have access to, but could be used by Council Planners as a reference when new consents come in. There is a potential for this to trigger the need for further assessment and engagement with mana whenua from the applicant.
d. What mechanisms are available to mana whenua for these sites to be protected and require the developer to avoid it (like wetlands).

A number of these tasks are underway by other units in Council. With regard to capturing public sites of significance and 'non-public' sites of significance, and engaging mana whenua where wetland restoration may be required, Council will work with mana whenua to display this data appropriately on the web-

viewer. Council will also work with mana whenua to provide them with access to this tool to assist in responding to resource consents and other Council queries.

Other protections for the catchment include:

- Adding the requirement for cultural impact assessments into the Means of Compliance table for Council and Developers (to be carried out prior to consent);
- Retention of existing riparian vegetation in the gully by means of gully reserve areas, as defined in the operative structure plan;
- Proposed on-lot and centralised device stormwater management measures to provide water quality treatment prior to discharge to the stream;
- A separate programme of works to progressively improve untreated stormwater run-off from historically developed areas which don't have water quality treatment;
- Archaeological investigations prior to Council and Developer works occurring in the vicinity of the stream banks, obtaining necessary authorities, and implementation of appropriate procedures for notifying Heritage NZ and iwi where cultural or historical items are discovered.

13.2 Public Health and Safety

Stormwater will be treated prior to discharge to the stream. The catchment is undergoing a change in land use from rural/pastoral use and associated run off to an urbanised catchment. As such, the composition of stormwater will change as additional treatment devices come on line. In general, the goal is to improve water quality to support contact recreation activities although there will be other influences such as the effects of the presence of bird life in some areas.

The design of devices with accessible water needs to allow for public safety and public health (algal blooms, mosquitos etc.). When correctly designed, it is considered that public health and safety will not be compromised by development. The RITS provides further details in this respect.

13.3 Flooding Hazards

General

The BMP measures for the catchment have due regard for either protecting or improving existing levels of flood protection. Flooding is controlled by the design requirements for attenuation and overland flow paths. Design requirements are more stringent where existing flooding is noted as an issue.

Existing flood levels and areas are shown in the hydraulic modelling outputs. Overland flows and ponding are typically controlled within road corridors in areas of existing development. This is an example of best practice working well and is a requirement of the RITS for all new development.

Development in the catchment has benefited from the deep gully system in which the stream is located. In all locations increased flood extents are confined to the main channel (gully) or within the low-lying areas of adjacent private land well below existing built floor levels (particularly immediately upstream of the Petersburg bridge crossing). Unmitigated flood levels are contained within the gully or where development has not occurred, having a less than minor effect.

Flooding effects are more notable further upstream where the gully system diminishes (e.g. Borman Road) so controls have been imposed on remaining development. The proposed control involves large event attenuation for which modelling has shown that a significant reduction in nuisance flooding should result.

Increases in flood hazard extent are observed across the entire existing brownfield residential area in the mapped MPD scenario. Impacts in existing urban brownfield are expected as the MPD scenario assumes infill development will not be mitigated. The mapped increases are exacerbated by the fact that ED scenario modelled does not incorporate an allowance for climate change rainfall intensity increase.

Impacts on existing (brownfield) private properties due to infill development are focused around the Resolution Dive – Thomas Road roundabout. A large stormwater main (1800mm) run below the roundabout with Resolution Drive forming a barrier to overland flow. Seven dwellings have been identified as likely being impacted by a flood hazard in the MPD scenario in this vicinity.

Remaining development is subject to the following in order to mitigate new effects:

- Pre development flood levels are not to be exceeded for the 10-year storm event. That is, the primary drainage network is required to be able to convey all runoff in a controlled manner to the Te Awa O Kātāpaki stream or the Waikato River.
- Development shall ensure no increase in downstream flooding as a result of earthworks, structures, or diversions, except that;
- Increases are permitted in designated overland flow and ponding areas which pose no inundation threat to properties – modelling has shown that this is feasible for the 100-year storm event without additional control, except up stream of Borman Road east
- Attenuation of the 100-year event to 80 % of pre-development flows is required upstream of Borman Road east to minimise nuisance flooding along Borman Road and in private property.

The predicted change in peak flood levels in the Te Awa O Kātāpaki Stream through the Southern Catchment will have a less than minor effect. Environmental mitigation is not related to peak flooding and is addressed through the attenuation and control of smaller more frequent events, and through planned erosion and remediation projects.

Otama-ngenge overland flow path

Flood flows from the adjacent Otama-ngenge catchment have been diverted to the Te Awa O Kātāpaki catchment to minimise flood increases through farmland downstream of the city boundary. The overland flowpath has been constructed as part of development and is secured through road drainage reserves and easements.

Upper, Lower and River North Catchments

The Upper, Lower and River North Catchments do not have any existing flooding issues that can or need to be mitigated through further assessment or upgrade projects. Controls for remaining development are covered in the General section above.

Southern Catchment

Some areas in the fully developed Southern Catchment have predicted flooding increases occurring with development and climate change, particularly around Thomas Road. The increase is primarily a result of climate change because the area is fully developed.

The Thomas Road flooding area is at the upstream end of an 1800 mm pipeline servicing the Southern Catchment. The 1800 mm pipeline discharges directly to the Te Awa O Kātāpaki Stream. The pipeline is

flat and is believed to be partially controlled by water level conditions at the outlet. The possibility that the increases were due to increased flood levels in the main Te Awa O Kātāpaki stream was reduced when more conservative modelling was undertaken with very little backwater effects observed. While a small portion of the flooding increase is as a result of development, most of the increase is as a result of predicted climate change which cannot be controlled for and remains uncertain.

Flooding of buildings is not indicated but the modelled flood level is close enough to buildings to warrant investigation. A floor level survey is recommended in the first instance to determine if floor levels are clear of the predicted flooding. If they are not, the following options exist, subject to assessment for effectiveness:

- Upgrade or duplicate the pipeline to the Te Awa O Kātāpaki stream
- Utilise Grosvenor park for flood storage by lowering it

Conclusion

There are several minor aspects of flooding that require additional investigation or assessment. However, most of the catchment has been developed in a manner that means there are not significant flooding risk or impacts above what is considered normal when having to convey large flow overland and in channels, through development. Controls are in place to limit adverse effects from the small area yet to be developed.

The results of the flood modelling indicate that the with the proposed flood attenuation measures in-place no additional private properties will impacted by flooding due to MPD development measures in a 100y event within the TAOK catchment.

Flood modelling results indicate that a small number of properties may become impacted by flood hazard based on the infill development assumptions. Brownfield flood impacts are predicted to be focused upstream of resolution Drive in Rototuna North.

13.4 Effect on Groundwater, Surface Water and Stream Base Flow

The introduction of impermeable surfaces has the potential to increase runoff and lower groundwater levels. A consequence of reduced groundwater level would be reduced stream base flow.

Stormwater runoff from developed areas has the potential to contain contaminants such as dust, litter, sediments, metals, hydrocarbons, and nutrients and can also have an elevated temperature. This can have adverse effects on groundwater and surface water quality.

These impacts cannot be entirely avoided but several the BMP measures are aimed at minimising the potential impact of development on groundwater, surface water and stream base flow.

Measures introduced to minimise the impacts include:

a) Promoting ground soakage even where this may only be efficient in dry periods
b) Reduced imperviousness and low impact design incorporating green corridors and vegetation
c) Provision of extended detention and volume control
d) Sediment control during construction

e) Rehabilitation of soils

The requirements of the ICMP are designed to minimise the likely impacts of development on groundwater levels and stream base flow as much as practical. Development also provides an opportunity to improve on the current situation in areas such as sediment runoff (refer to CLM estimates).

A recommendation of the ICMP is that construction sites have flocculation ponds. Enforcement of sediment control during house building will also be important although the pre-development construction of major treatment devices will lower these impacts.

13.5 Recreation and Amenity Values

Development provides an opportunity to create public reserves and access to the gully system. The gully system can provide an important natural link within a new urban area, providing a new public amenity.

Ponds, wetlands, and basins can also function as an amenity if safe public access is provided. An example is the pond system within the Rototuna Town Centre, alongside proposed reserve and playing fields.

13.6 Ecology (including in-stream and riparian)

Due to the potential ecological value of the lower Te Awa O Kātāpaki Stream (downstream of Magellan Lake), it is considered imperative that the ICMP provides a robust and sustainable approach to managing discharges from development in the catchment. The stream system provides habitat for fauna and flora and supports fish and birds. Protection of the stream and gully system is therefore of key importance.

While impacts on the ecology of the area cannot be entirely avoided, the required BMP measures are aimed at minimising adverse effects as much as practical and where possible, improving the situation.

The required BMP measures are aimed at achieving at least 75% TSS removal with byproduct reductions in other contaminants. Extended detention, volume control and attenuation will further reduce the effects of increased flow rates and durations. Given the desire to further improve the habitat and maintain or restore the original high value of stream, coupled with the continued change in landuse from rural/pastoral to urbanization, it is considered that these minimum standards are necessary in order to provide an acceptable level of protection and restore the original quality, as far as practical.

Development also provides an opportunity to protect existing riparian vegetation, undertake gully restoration and provide additional habitat. This will not only protect the gully system, but will also enhance it further, resulting in an ecological corridor with high scenic and recreational values.

Existing development in the lower gully system is almost complete. Remaining pockets of development will be subject to minimum setbacks and improvement planting requirements. HCC will carry out ongoing gully improvement in the form of planting and habitat creation. It is envisaged that this will typically be carried out in parallel with any erosion and stability works arising from periodic inspections of the gully system.

In respect of the above, work durations in the gully will be minimised and good integration between engineered protection and mitigation through planting and habitat will be able to be achieved.

13.7 Aesthetics

Litter is a problem in urban areas, particularly along roads. Monitoring of the streams and tributaries under the CSDC will be used to evaluate the frequency of litter removal and street maintenance schedules. This will ensure litter is not an issue.

It is considered that the sustainable urban design elements of the measures proposed will soften the impact of development. This approach will provide elements that have a more natural feel. Also, opening the gully system for public access and view will improve aesthetic appeal.

Standing water has the potential to form algal blooms in the long term and could provide a collection point for litter. The issues can be avoided by careful design and ongoing maintenance.

Based upon the above it is considered that the development of the area provides an opportunity to have a positive aesthetic effect, especially in areas adjacent to the gully system.

13.8 Effect on Existing Infrastructure

This ICMP requires that discharge rates to the reticulated network from developed areas will be no greater than pre-development rates. As such no adverse effects would be expected on the downstream infrastructure.

The southern catchment is fully developed. There will be no future impact on minor infrastructure from developed areas. There are, however, several major drainage components along the main gully which receive flow from existing and proposed developed areas as follows:

- River Road culvert
- Magellan Lake
    - Borman Road pipeline and culverts

Existing flow rates for the sub-catchments were derived from the hydraulic modeling work undertaken as part of the ICMP. Modelling of the ‘developed managed’ scenario shows that, with appropriate controls, there is no adverse effect on existing major drainage infrastructure.

The River Road culvert has recently been upgraded to cater for a 1% ARI event.

Magellan Lake, the Borman Road pipeline, and minor road culverts in the vicinity were designed with future development in mind so will not be affected. Existing development on the southern side of Borman Road has attenuation ponds prior to discharge to the pipeline.

As part of ongoing operation and monitoring, the floodways, and lakes (Magellan and Town Centre) will be monitored and optimised to provide maximum benefit in terms of attenuation, permanent volume, residence time, and outlet velocities.

13.9 Existing Authorised Use Activities

Existing discharge consents are held by both HCC (the Comprehensive Stormwater Discharge Consent, CSDC) and private landowners. Private landowner consent for stormwater discharge, relate to

development works that have been undertaken, or are planned, in the catchment area. These will eventually transfer to HCC.

There are no consented ground water takes in the study area based on WRC records. There are bores shown on WRC's maps. These are assumed to be private rural bores which will be abandoned once development occurs.
When the area is developed, water supply will be reticulated.

It is not considered that development of the area would have any adverse effect on any authorised use activities.

13.10 Assessment of ICMP against CSDC Conditions

Table 13-1 – Assessment of ICMP against CSDC Conditions

Condition	Criteria	ICMP assessment against condition requirement
6	Increasing the scale or intensity of adverse effects on the network	This ICMP lists quality and quantity parameters to be met and requires that any discharges to Te Awa O Kātāpaki must be to consented devices which can manage the inputs. See Means of Compliance table in Section 12.3.
7	Implementation of BPO to mitigate actual and potential effects	See means of compliance Section (aligned to BPOs) which requires treatment and attenuation to parameter deemed appropriate to protect the catchment. See also Future Actions Section 15.1.
8	Activities managed to meet conditions	Key stakeholder engagement. BPOs and means of compliance (Sections 11 and 12).
9	Avoid as far as practicable, minimise quantity effects of scour, erosion, sediment deposition, flooding, and adverse effects on aquatic ecosystems.	Assessment has been carried out to determine stream condition and ecological value. A capacity assessment has been done and a comparative contaminant load assessment has been carried out. BPOs which address protection of ecological value, drainage area LOS, potential flooding include: • 2-year and 10-year post-development flow attenuated to respective 2-year and 10-year pre-development flow in the upper catchments. • 100-year post development flow attenuated to 80% of pre-development flow in upper east catchments discharging via Borman Road. • 24mm, 24 hour extended detention for greenfield development.
10	Addressing adverse stormwater quantity effects - Procedure	Procedure has been referenced in Section 14.
11	Fish passage review	Assessment of fish passage constraints has been carried out and there are no identified issues. Fish passage requirements have been included in BMP 10 and Operational Objectives 4 and 5 (Section 6.2).

12	Devices operated and maintained	Stormwater BMP 4 and BMP 8 refer to requirement for O&M plans.
14	Avoid as far as practicable, minimise discharges of oil, grease, scums or foams and suspended solids in water bodies after mixing	Operational requirement 1 references the requirement for appropriate treatment device and for roading, devices that will remove hydrocarbons.
15	Avoid as far as practicable, minimise discharges of suspended solids	Operational Objective 1 and the Stormwater Treatment BPO (Section 8.1.1) and the Means of Compliance Section 12) require treatment device to remove 75% TSS, and require construction controls.
16	Avoid as far as practicable, minimise discharges of hazardous substances	Operational Objective 1 (Section 6.2) requires comprehensive treatment system such as interception devices. (The Hamilton City Council stormwater bylaw also requires a Pollution Control Plan).
17	Avoid as far as practicable, minimise discharges of micro-organisms	Means of Compliance (Section 12.3) requires a network that has adequate capacity to serve the whole sub-catchment within the city boundary and requires compliance design to minimise inflow and infiltration of stormwater to the wastewater system.
18	Avoid as far as practicable, minimise discharges that will adversely affect aquatic ecosystems in terms of oxygen, pH, suspended solids, biological growths, water temperature, turbidity, ammoniacal nitrogen and other contaminants concentrations that exceed USEPA max concentration.	Ecological assessment and contaminant loading estimates have shown that treatment devices are necessary. The proposed treatment solutions align with development already undertaken in the catchment. This includes centralised wetlands with >80% wetland plant cover. Stormwater BMP 3 requires the consideration of a treatment train for all development and specific treatments for roads and high-risk sites. Design requirements for discharge parameters (Section 12.2) are in line with CSDC requirements and has the addition of a water temperature requirement of <23° Celsius at the point of discharge to a waterway and water temperature increase of no more than 3° Celsius. Stormwater BMP 13 requires construction controls via Waikato Regional Council and Hamilton City Council stormwater bylaw to manage construction effects and high-risk discharges.
20	Stormwater catchpits to be capable of capturing majority of gross pollutants	Standard RITS road catch pit grates and sump requirements will prevent large objects from entering the system and capture coarse sediments.
21	Stormwater devices are to provide best practicable treatment efficiency at all times.	Stormwater BMP 4 and BMP 8 refer to the requirement for O&M plans.
23	Avoid as far as practicable, minimise discharges of	Operational Objective 1 (Section 6.2) requires comprehensive treatment system such as interception

	routine contaminants from high risk catchments	devices. (The Hamilton City Council stormwater bylaw also requires a Pollution Control Plan).
32 and 33	Promotion of Sustainable Subdivision development and LIUD measures	BMPs provide for water sensitive design, wetlands vs ponds, RITS implementation.

14 Monitoring

HCC holds Waikato Regional Council resource consents for stormwater discharges, water take, and wastewater discharges. HCC's CSDC) authorises stormwater discharges from HCC's stormwater network, including any new discharges which are transferred to HCC and accepted via the technical certification process described in Condition 3 of the CSDC. HCC was required to prepare a monitoring plan to assess the adverse effects of municipal stormwater diversion and discharge activities on the environment in accordance with the requirements of Condition 37 of the CSDC. The original monitoring plan was approved by Waikato Regional Council in 2013 (T+T 2012). The original monitoring plan has been updated and incorporated into a comprehensive citywide Stormwater and Receiving Environment Monitoring Plan (SREMP, T+T, 2019). The SREMP has the following purposes:

- To assist HCC to monitor and enable all relevant agencies to understand the effects of stormwater discharges and compliance with the CSDC;
- To assist HCC in determining if a response is required;
- To assist HCC in prioritising stormwater quality improvements; and
- To assist HCC in determining if catchment management initiatives are needed or successful.

The SREMP is an adaptive monitoring programme that includes regular review to capture any new monitoring requirements as they arise and monitoring site priorities and frequencies that change in response to observed data and catchment development. The general thrust for the updated plan is a strong focus on receiving environment monitoring (as opposed to device monitoring), with the development of catchment/stream specific targets. Exceedances of established targets would initiate a response, which could comprise further investigation or action.

The ICMP Ecology Report made a series of recommendations for ongoing monitoring, with reference to the city-wide CSDC monitoring plan for some aspects. The following sections outline the proposed monitoring programme for the TAOK catchment on the basis of HCC's SREMP while incorporating the ICMP Ecology Report recommendations as appropriate.

14.1 Catchment monitoring

The SREMP includes a network of monitoring sites throughout the TAOK stream network. The effects of existing and new stormwater discharges and stormwater improvement and management initiatives on freshwater receiving environments in the TAOK Catchment will be monitored primarily through the SREMP. Monitoring of the effects of development will also occur under any specific subdivision discharge consent monitoring requirements prior to those consents being transferred to HCC and captured under the CSDC and SREMP.

Monitoring site locations for the TAOK catchment are shown in Figure 25 below. TAOK monitoring site locations were established prior to the bulk of the development occurring upstream of Resolution Drive. This ICMP therefore proposes a 6th stream ecological monitoring site is added to the ongoing monitoring programme in the upper catchment (Site T6).

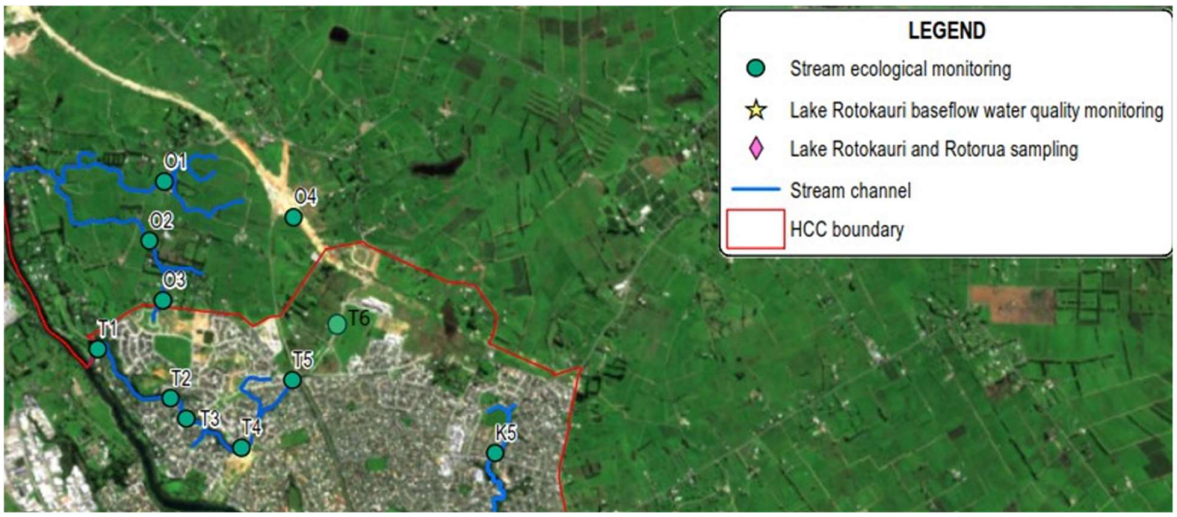


Figure 31 – Catchment Monitoring sites (T1-T6)

14.2 Water quality monitoring

The SREMP (CSDC driven monitoring programme) includes visual inspection-based water quality monitoring in the TAOK. The water components of the SREMP that are relevant to the TAOK catchment are described in detail in the SREMP and summarised below. Site locations are shown on Figure 25. In all cases the monitoring is adaptive (site locations and frequency can be amended as needed) and there are triggered actions and responses. The SREMP should be referred to for detail.

- **Visual monitoring:** This programme involves visual monitoring of selected stream points and stormwater outlets within specific catchments to visually assess the health of the water courses and identify any visual signs of contaminants in stormwater (conspicuous oil or grease films, scums or foams, floatable suspended materials, conspicuous change in colour or visual clarity). Established sites at this stage comprise the main TAOK Stream at River Road (Site T1). A specific scoring system has been developed that results in increased monitoring frequency and or response as appropriate which may include follow up investigation, audits under the Stormwater Bylaw or immediate actions to address the identified issue.
- **Stormwater runoff quality**: Stormwater runoff quality and flow monitoring using flow proportional composite sampling methods will be undertaken as an investigative tool. This may be undertaken in response to receiving environment data, to determine the contaminant load from a specific outlet or to validate predictive modelling outputs and/or the performance of stormwater treatment infrastructure.
- **Water quality monitoring:** The ICMP Ecology Report recommends that water quality monitoring is undertaken at each of the survey sites included in that study according with HCC's CSDC methodology. This ICMP proposes that this is undertaken in conjunction with the SREMP monitoring programme at Sites T1 and T4. The sampling includes testing for dissolved & total metals, (Cu, Zn) and nutrient parameters. The primary objective of this monitoring is to understand the contribution of the urban area on water quality and the duration and frequency of this monitoring will be reviewed annually.

14.3 Ecological monitoring

The SREMP (and previous CSDSC monitoring plan) has an established network of monitoring sites throughout Hamilton City, including 5 sites in the TAOK catchment. Ecological monitoring includes habitat quality using WRC's Regional Ecological Monitoring of Streams (REMS) protocol, macroinvertebrate and sediment quality sampling. Sites are visited and sampled annually, two yearly or four yearly depending on catchment development progress and data results and trends. Site locations are shown on Figure 25. with the key components of the monitoring summarised below.

- **REMS:** Standard WRC REMS habitat assessment protocol covering riparian and in-stream conditions that provides a semi-quantitative score.
- **Macroinvertebrates:** A single macro-invertebrate sample will be collected from each site (100 m reach) in accordance with the WRC Guidelines for Ecological Assessment of Freshwater Environments. Macroinvertebrate samples are processed following a 200 fixed count methodology in accordance with the guidelines.
- **Sediment quality:** A composite sediment quality sample is collected from surface sediments at each habitat quality monitoring site. Samples are tested for total organic carbon, polynuclear aromatic hydrocarbons (PAHs) (every fourth sampling occasion) and total recoverable (TR) and Extractable (E) copper and zinc (every sampling occasion).

The ICMP Ecology Report identifies metal contamination of watercress as a potential human health risk and report recommends that additional sediment quality (arsenic and zinc) monitoring is undertaken. We suggest that arsenic could be added to the sediment suite and that all six of the established (and proposed) TAOK ongoing monitoring sites are sampled for sediment quality as part the next monitoring round (scheduled for summer 2021). Subsequent response with respect to the watercress issue can be developed through the SREMP process.

14.4 Stream channel and erosion monitoring

HCC has developed an erosion susceptibility assessment for Hamilton City streams known as the Rapid Geomorphic Erosion Assessment (RGEA) Methodology. The RGEA method was developed at WRC's suggestion and aims to provide rapid baseline information on the bank and bed stability of a watercourse and susceptibility to erosion. The purpose is to aid decision making with regard to prioritising stream reaches requiring stabilisation interventions and therefore a concept programme of works to for LTP funding decisions, determine developer contributions and provide guidance for Project Watershed.

An erosion walkover of the TAOK stream has been undertaken using the Receiving Environment Module methodology in 2016 (Morphum & T+T). The SREMP has considered this assessment and captures ongoing monitoring requirements for the TAOK Stream network and should be consulted for detail. The monitoring will be undertaken at and along targeted stream sites and reaches and the focus will be on "Erosion hot spots" and stream reaches identified as having poor stability (high erosion susceptibility).
Hot spot monitoring will follow the methodology outlined in the ICMP receiving environment module along with recording the mechanism for erosion at the site.

For stream stability. On the first occasion that "poor" stability reaches are monitored the full RGEA methodology will be followed to ensure data for ongoing monitoring are consistent. Representative photographic monitoring points (photo points) within the reach will also be established and GPS

coordinates collected. Subsequent monitoring visits will comprise the collection of photographs at established photo points and collection of the Bank Height and Bank Angle components of the RGEA.

14.5 Magellan Lake

HCC hold WRC resource consents 115069, 113670, 113673 and 113674 authorising the placement and operation of Magellan Lake. An operations and maintenance plan (O&M Plan) was prepared for Magellan Lake in accordance with the consents and approved by WRC in February 2014[38]. The approved O&M Plan includes monitoring requirements for ongoing monitoring. The ongoing monitoring will be undertaken as part of HCC's SREMP and include.

- Algal blooms (cyanobacteria) – primarily visual inspections during summer months with additional sampling undertaken if blooms are observed.
- Avian botulism – Routine inspections for avian botulism will be undertaken at the same frequency as algal bloom monitoring above. Dead ducks will be removed and disposed of as required.
- Macrophyte communities – Qualitative assessments of the lake macrophyte community will also be undertaken during the monthly or two monthly inspections. In general, this monitoring will include observations on the diversity and abundance of macrophyte species from the lake edge and in particular the presence of any exotic species.
- Habitat structures and riparian planting downstream of the lake outlet. To be inspected annually and any issues reported.

14.6 Reporting

Monitoring reporting for the TAOK catchment will be undertaken as part of the Municipal Stormwater Network Operation Annual Report which is to be submitted to WRC by 1 July each year. The report will contain recommendations on any changes that may be needed to the monitoring plan for the following year in line with the adaptive approach set out in the SREMP. All raw data and monitoring assessments/reporting relevant to CSDC requirements or collected in conjunction with a WRC monitoring programme will be made available to WRC on request.

15 Information Gaps

The status of the catchment is fully developed in the south and under construction, consented or under detailed planning for development elsewhere. This level of development means that there is negligible benefit in carrying out significant studies or investigations (this does not preclude ongoing assessment and monitoring which will feed into future ICMP revisions).

Notwithstanding this, the objectives of this ICMP will need to be applied on an ongoing basis. This is particularly relevant in terms of enhancement, improvement and access to the gully and stream system. Investigation and monitoring will be of benefit for the stream.

New information will be incorporated where relevant, into future revisions of the ICMP. Refer to Tables 15-1 and 15-3 which identifies actions to implement the ICMP, and outstanding and potential information requirements, investigations and projects.

[38] T+T, 2014. Magellan Lake Operations and Maintenance Plan. Consultancy report prepared for CDL Land (NZ) Ltd.

15.1 Future Actions

The following are recognised future actions considered important to meet the outcomes of the ICMP. These will need to be addressed by developers at the time of their proposals or subsequently by Hamilton City Council and reflected in future revisions of the ICMP. Opportunities that should be sought by parties in the hydrological catchment are also listed.

Table 15-1 Te Awa O Kātāpaki Programme of Works 10 year (2021 – 2031)

Programme	Business Owner	Estimated Capital cost		Year - Capital Costs											Annual O&M	
		10yr	30yr Plan	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Beyond 2030	2030	City Full
Watercourse Erosion	City Waters	$192,000	$3,947,000									$53,000	$139,000		Not assessed	Not assessed
Capital forecast in 30 year plan will cover all erosion projects identified in the ICMP. Prioritisation for erosion projects is undertaken on a city-wide basis.																
Watercourse Restoration (Nature in the City – city wide)	Parks	$1,930,000		$581,000	$970,775	$1,483,138	$1,593,594	$1,696,129	$2,311,686	$2,811,220	$2,470,958	$2,622,158	$2,756,664			
Watercourse restoration is a city-wide program. Parks have indicated that the Te Awa O Katapaki catchment is a high priority within the City. Restoration works are expected to start in this catchment within the LTP period.																
Fish Passage	City Waters	-	-													
Three fish barriers identified in the catchment- two natural, one man-made. No barriers require removal as man-made barrier is protecting upstream mudfish community.																
Flood Management	City Development	$528,000			$155,000	$372,000									Not assessed	Not assessed
Flood management funding has been secured in the current LTP to investigate brownfield flooding issues. Prioritisation is reviewed on an on-going basis																
Overland Flow Path Investigation and Improvements	City Development	$2,095,000				$80,000	$244,000	$1,683,000	$45,000	$43,000					Not assessed	Not assessed
The ICMP recommends projects as shown on SMV2 Map xx 4 projects in LTP – OLFP Borman, OLFP Bourn Brook, OLFP Kirkdale. Prioritisation is reviewed on an on-going basis																
Existing Device Improvements	City Waters Assets	$1,661,000		$50,000	$161,000	$102,000	$160,000	$164,000	$395,000	$265,000	$319,000	$47,000			Not assessed	Not assessed
This is City Wide. ICMP rec's $3M as per table XX, and programme will be undertaken as MCA high priorities enable. Prioritisation is reviewed on an on-going basis.																
Greenfields Stormwater Devices	Strategic Development	$6,489,000		$ 57,000	$178,000	$608,000	$418,000	$429,000	$33,000	$ 34,000	$238,000	$2,792,000	$1,701,000			
Funding has been secured to upsize four sub-catchment scaled devices to ensure that whole-of-catchment treatment outcome can be achieved. Prioritisation is reviewed on an on-going basis as development proceeds.																
Brownfields Stormwater Devices	City Development	Nil	Significant investment												Not assessed	Not assessed
HCC are developing and forecasting a program of new brownfield treatment device constructed to manage stormwater in existing urban areas. Currently no funding within the LTP period, however significant invest forecast over 30 year program. This will be further resolved in future LTP updates.																

Table 15-2 – Future Actions including capital works

No.	Future action	Requirement type	Anticipated timeline (responsibility)
General			
1	ICMP is implemented once the ICMP is finalised and approved by the Hamilton City Council: • Place the ICMP (and appendices) on the Hamilton City Council website • Inform key stakeholders (internal and external) • Pass to the Hamilton City Council Compliance Team for education purposes in accordance with Hamilton City Council CSDS requirements Meet with Hamilton City Council Development Engineers, City Planning, Planning Guidance Unit and Building Unit to ensure requirements within the ICMP (specifically BPSOs, Design Parameters and Means of Compliance are sufficiently understood and implemented through Resource Consents and Building Consents (as required)	Internal Stakeholder Implementation workshop	Once approved (Hamilton City Council)
2	Integrate with the Hamilton City Council CSDC Monitoring Programme – this includes the proposed catchment monitoring, as per Section 8 of this document, in the Hamilton City Council CSDS Monitoring Programme when it is reviewed / updated (as per Condition 37 of the Hamilton City Council CSDC). This should include consideration of detailed monitoring methods to ensure consistency with baseline methods and any broad scale updates to the Hamilton City Council CSDC Monitoring Programme, if/ when required	Monitoring requirement	Once approved (Hamilton City Council)
3	Proposed Waikato Regional Plan Change 1 – Waikato and Waipa River Catchments (Healthy Rivers): Seek guidance from WRC on the short term and long-term numerical water quality targets for the Waikato and Waipa River Catchments, in particular determine how these targets relate to urban stormwater discharges.	Statutory compliance	Following WRC Plan Change 1 (Hamilton City Council)
Stormwater Management			
1	Assessment of flooding areas (existing and MPD) to see what can be mitigated, practically and cost effectively. Preference will be given to areas of 100-year ARI flooding with higher hazard or where increases in flooding are predicted as a result of development (note that no areas of flooding are predicted with a risk to buildings).	Investigation	As LTP funding allows from flood management program (Hamilton City Council).
2	Specific data and maps such as all existing OLFP, OLFP direction, extent, mitigated and unmitigated OLFP, intersecting properties, OLFP catchment boundaries, and verification.	Desktop / data assessment	As LTP funding allows from flood management program (Hamilton City Council). OLFP based on 2019 LiDAR data due for public release in 2022.
3	If property is likely to be affected the OLFP should be modelled in more detail when the topography is determined and a conservative approach to limit the footprint of nearby development in the meantime to ensure no future building is compromised.	Assessment	As required through development.

No.	Future action	Requirement type	Anticipated timeline (responsibility)
4	Show likely flows of the Glaisdale OLFP in a 100-year event. A simplified modeling method may be used – to be confirmed.	Assessment	Complete
Aquatic Habitat and Erosion			
5	Scour and sedimentation at discharge points (see section Natural values)	Investigation	As required through development via RITS and erosion control LTP programme.
5a	Review all existing untreated brownfield areas and create a programme for new devices and upgrade existing devices. Implement a programme as LTP funding and development opportunities allow.		As LTP funding allows from brownfield new devices and device upgrade programmes (Hamilton City Council).
6	Erosion mitigation; refer to: • Morphum Report (May 2017) for works required in Stream up to River road culvert D-2301027 • Stantec Report (March 2017) for works downstream of River Road culvert to river confluence (D-2353620). • T&T Review of the Erosion Issues - Te Awa o Kātāpaki Stream River Road Reach (D-2798802) Also refer to Section 3.9 and Figure 18.	Design	As LTP funding allows from erosion mitigation program (Hamilton City Council).
Cultural and Archaeology			
7	Archaeological assessment of extent of Te Awa o Kātāpaki Stream (extent to be confirmed), to identify potential unidentified sites of cultural significance prior to downstream erosion works commencing	Assessment and Heritage Authority prior to design and consenting erosion works	As required by development.
Water quality			
8	Magellan Lake performance improvement (see T&T and AECOM reports for investigations done to date)	Design and consenting	As LTP funding allows from brownfield device upgrade programme (Hamilton City Council).
8a	Public Health signage regarding unsuitability of water within catchment for contact recreation and harvest of plant/animals for human consumption (Watercress, coarse fish).	Physical works	2022 (Hamilton City Council).
Growth			
9	Greenfield wetland design	Design	At time of development
Wastewater management			
10	Moonlight wastewater pump station - emergency storage.	Physical works	Through wastewater masterplan.
10a	Northern Te Awa O Kātāpaki Catchment to be measured and calibrated in future model upgrades, once development is complete. to eliminate any predicted spill issues and provide a more accurate assessment of the network.	Assessment	Through wastewater masterplan.
11	Rototuna West - emergency storage. A third pump may be required near maximum development. Wet weather run times and the frequency of use of storage to be monitored to determine if and when the third pump should be installed.	Physical works Assessment	Through wastewater masterplan.
	On-going city wide programme of monitoring for incorrectly installed cross connections (wastewater to stormwater) discharging into the catchment.	Monitoring	Ongoing (Hamilton City Council - City Waters)

No.	Future action	Requirement type	Anticipated timeline (responsibility)
Education			
12	Once the ICMP is finalised and approved by the Hamilton City Council Project Governance Group, key stakeholders will be informed. The ICMP will be placed on the Hamilton City Council website, added to the agenda of the Developers Forum quarterly meeting, and passed to the Hamilton City Council Compliance team for Education purposes under the CSDC requirements.	Education	Once approved (Hamilton City Council)

Education initiatives support the implementation of ICMPs. Education initiatives relating to the Te Awa o Kātāpaki ICMP are listed in Table 15-3.

Table 15-3 -Education Initiatives

Initiative	Description	Action
Three Waters Practice Notes	Guidance notes to developers and development engineers on implementation of three waters infrastructure including on-lot requirements.	An update to the Practice Notes is underway.
GIS means of compliance viewer	Viewer to communicate simplified means of compliance for internal staff use.	Te Awa o Kātāpaki ICMP means of compliance have been added to the viewer.
Annual RITS workshop	An annual workshop for consultants to be made familiar with the RITS, including any updates.	A recommendation will be provided to the WLASS to run an annual RITS workshop.
Update Councils Flood Viewer (external and internal)	Council has flood viewers for external and internal use that display flood hazard	Flood data has been provided for update into the flood viewer.
On-lot consent notices	Consent notices are placed on consents to ensure that on-lot infrastructure is constructed and maintained.	Current standard practice.
Council Community Plantings Page	Councils website has a Community Planting page with links to groups and resources relating to restoration planting	Continue to operate and maintain the Community Plantings Page.
Council Gully Restoration Guide	The Council has a gully restoration guide.	The ICMP has recommended updates to the gully restoration guide to the Parks and Open Spaces team.

Table 15-4 identifies the actions required to implement the ICMP. Where these actions are not the responsibility of the Te Awa o Kātāpaki ICMP Project Manager, the responsible party is to be informed by the project manager.

Table 15-5 – Actions to implement the ICMP

Issue	Action	Responsibility
Update Council Gully Restoration Guide	Update the Council Gully Restoration Guide to give effect to maatauranga Maaori values (including, but not limited to, mahinga kai and rongoa), in consultation with mana whenua and Waikato-Tainui. Updates should also consider guidance on appropriate locations for flax, which may need to be set back from unstable stream banks due to poor root structure.	Hamilton City Council Parks and Open Spaces Team
Flood Modelling Communication	Flood mapping is to be communicated through the new HCC flood viewer, and flood data to be provided to City Planning to inform any changes to the ODP flood hazard maps.	Strategic Development and City Planning
Wastewater	Cross connection and I&I issues reported to City Waters Operations team to inform programme of works. Programme of works co-ordinated with Wastewater Master Plan V3.	City Waters Operations Team Wastewater Master Plan
Implementation Auditing and Enforcement	To ensure that HCC maintains the necessary levels of control over its stormwater network to meet relevant statutory, policy, CSDC and ICMP requirements: • Confirm the appropriate regulatory mechanism(s) to ensure that on-lot stormwater management measures are appropriately mandated and legally binding (between HCC and lot owners), if/where these form part of the overall management suite. This may be via Consent Notices or other forms of covenants/agreements and will need to include maintenance obligations to ensure that long term performance is maintained. • Review and amend, as necessary, internal plans and procedures relating to stormwater asset maintenance (private and public) to ensure that all stormwater management measures are appropriately operated and maintained. These may include, but are not necessarily limited to, the HCC Stormwater Management Plan and the Stormwater Activity Management Plan.	Stormwater AMP

Table 15-5 – Actions to implement the ICMP		
Issue	**Action**	**Responsibility**
Lower Contaminant Transportation	Advocacy for lower (per person) contaminant yield transport mechanisms such as rail, public transport, cycling and walking. Advocacy for transport renewals to include retrofit stormwater treatment where feasible.	Advocacy to and through Stormwater Master Plan, City Transport, Access Hamilton strategy, and Stormwater AMP
Stream bed degradation	Consideration should be given in future iterations of the Stormwater Master Plan of the effects of river undercutting on streambed degradation	Stormwater Master Plan
Heavy Metals Monitoring	MURB study should incorporate monitoring of heavy metals.	MURB

15.2 Mechanisms for implementing measures

Mechanisms for implementing measures include:

Development applications – Developments will be assessed against each of these documents at the time of resource consent and/or building consent application. Resource consent conditions will be written and enforced accordingly.

See Appendix C for network service plans to assist in development proposals. Developers will need to check with Hamilton City Council on the status of the plans in this ICMP, catchment performance and where resource consent is required, should participate in pre-application meetings to understand requirements prior to development of proposals.

Enforcement –District Plan and Bylaws – Council has adopted a stormwater bylaw46 which sets out Councils powers under the Local Government Act to manage, regulate and protect, and to prevent the misuse of Council's land, structures or infrastructure associated with stormwater drainage. This will be supported by an Education Strategy.

Councils Long Term Plan – The LTP is used as a funding mechanism for infrastructure required for the Te Awa O Kātāpaki. ICMP's will contribute to funding decisions on infrastructure projects in the LTP.

Existing programmes such as:
- Planned maintenance[39] and operational improvements
- Asset renewal programmes
- Design and development in accordance with Regional Infrastructure Technical Specifications
- Customer service level (satisfaction surveys, complaints, monitoring)

Education strategy – this requires effective internal and external communication

[39] For example, road catchpits and sumps are currently cleaned out on an annual cyclic basis. However, streets with known leaf fall problems which are swept up to three times a week to forestall blockages.

Incorporate into City Waters education strategy and assess appropriate communications plan within one-month ICMP approval. The strategy needs to ensure that affected Units understand and apply ICMP content and implement though mechanisms such as consent approval processes and conditions. The external communication strategy needs to ensure that the ICMP is understood, referenced in consent application documents and by key stakeholders, BPOs are adopted and there are no buildings exposed to unacceptable levels of risk from flood hazards. Measures will include: Roadshow, Intranet, Website – ICMP, Website – FAQ, Territorial authority websites where appropriate.

16 Further Assessment for District Planning

No changes or new rules are required in the District Plan as a result of this ICMP.

17 ICMP Review

This document will be reviewed every five to seven years[40]. However, should there be demonstrable adverse effects identified through monitoring, or significant changes in policies and structure plans, the ICMP will be reviewed earlier. For demonstrable adverse effects, the Waikato Regional Council report procedure (as required by condition 10 of the CSDC) shall be carried out. Developers should be aware that changes to ICMP objectives may mean that different BPOs will be required. Such changes will be subject to consultation processes.

Hamilton City Council will monitor designs and construction as development progresses. Where approved designs or as built construction changes the outcome, the application of BPOs or the nature of the BPOs in the ICMP may need to be changed. These could differ from those already implemented by earlier developments in the catchment. Changes will only generally be made if a more practicable option is identified. The exception to this is where implementation results in the identification of an environmental shortcoming which requires a more effective BPO.

A reduction in requirements will not be made for minor improvements against the objectives. For a fundamental change to the ICMP objectives to be made, the positive impact of actual development will need to be significant and measurable. The same approach will generally apply to the application of more stringent requirements, but it is acknowledged that adverse effects and degradation can be a slow and cumulative process. A more proactive approach to managing the effects of stormwater discharges will be undertaken where a minor but consistently measurable reduction in water and/or habitat quality and/or bank stability is observed

Significant ICMP changes will require an internal Hamilton City Council Group review process, stakeholder consultation and approval by Waikato Regional Council. Minor changes will be discussed and agreed with Waikato Regional Council where this is relevant to the Hamilton City Council CSDC.

Potential amendments may also be required to any of the following:

a) Associated Structure Plan/District Plan
b) Hamilton City Council Stormwater Management Plan
c) Relevant bylaw or policy
d) The relevant activity management plan.
e) CSDC Monitoring Programme

[40] This term is considered appropriate on the basis of development which is estimated to be complete in the HAMILTON CITY COUNCIL development area in 4 years' time, sufficient monitoring data, flood hazard assessment, ability to review critical requirements through other mechanisms such as SMP reviews and the ability to amend the ICMP at any time if adverse effects are identified.

18 Glossary of Terms

Average Recurrence Interval (ARI): A statistical estimate of the average period in years between the occurrences of an event of a given size or larger.

Auckland Council Technical Publication 10 (TP10): A design guideline document that outlines and demonstrates the (ex) ARC‟s preferred design approach for stormwater management devices. Specifically, this includes design guidance for water quality and water quantity. This document is under review by Auckland Council and the new documents will automatically apply as the new guide to support this CMP.

Best Practicable Option: The best solution to achieve the objectives of the ICMP considering benefits, practicality, and cost. Where there are multiple options available the Best Practicable Option will be assessed and adopted within the Best Management Practices for the catchment.

Best Practice Requirement: The best method for preventing or minimising adverse effects on the environment, having regard to:

- The nature of the discharge or emission and the sensitivity of the receiving environment to adverse effects; and
- The financial implications, and the effects on the environment, of that option when compared with other options; and
- The current state of technical knowledge and the likelihood that the option can be successfully applied.

Base Flow: Base flow is the normal flow in a stream between storm events. This flow is supplied by groundwater.

Buffer: A vegetated strip immediately adjacent to a water body. The primary function of buffers is to protect the receiving water from sediment and pollutants derived from upstream areas. Ancillary benefits may include infiltration of rainfall and habitat enhancement.

Catchment: The area of land drained by a stream or river system, or the boundary of an area where all surface water drains to a common point.

Catchment Management Plan: A management plan devised to manage land, its environmental and social resources on a catchment basis.

Extended Detention Device: This is a stormwater device that temporarily retains initial stormwater runoff and discharges it over 24 hours.

Filter Strip: A vegetated boundary characterized by uniform mild slopes. Filter strips may be provided downslope of developed areas to trap sediment and sediment-borne pollutants and to reduce imperviousness. Filter strips located adjacent to water bodies are called buffers.

Flood Hazard Mapping: Defines flood hazard areas using flood levels established as part of flood hazard studies.

Flow Attenuation: The process of reducing the peak flow rate by redistributing the same volume of flow over a longer period, i.e. by using detention structures.

Green roof (or eco-roof or living roof): A roof of a building that is partially or completely covered with vegetation and planted over a waterproofing membrane. The sustainable design method treats storm water runoff, reduces heat transfer and energy consumption.

Groundwater Recharge: Increasing the amount of groundwater in storage via percolating rainwater.

Hydraulic Model: A computer model of a watercourse used to evaluate the hydraulic conditions of water flow through natural rivers and other channels.

Impervious surface: Those surfaces in the landscape that cannot infiltrate rainfall, such as rooftops, road pavements, footpaths, driveways, and compacted earth.

Infiltration: The downward movement of water from the surface of the land to subsoil.

Integrated Catchment Management Plan: A management plan devised to manage natural resources on catchment basis to achieve sustainable use which provides for social and economic benefit.

Perennial stream: A stream that has water flow all year.

Rain garden: A planted depression or raised enclosed bed that is designed to absorb contaminants in stormwater runoff which are generated from impervious areas such as roofs, roads, paving, and lawn areas. The water will percolate through the rain garden prior to discharge, which is either through natural soakage, to low velocity overland flow or a piped network.

Riparian Corridor: Generally, the vegetated land adjacent to a watercourse.

Sand filter: A concrete chamber with graded sand that is designed to absorb contaminants in stormwater runoff. The water will percolate through the sand layer prior to discharge through a piped outlet.

Swale: A drainage depression along which stormwater flows. It is usually grassed and regularly mowed. It collects and treats water by slowing the flow and allowing solids to drop out of the water prior to discharging via a cesspit to a piped network.

Treatment Train: A 'Treatment Train' consists of sequential components that contribute to the treatment of stormwater before it discharges to natural watercourses.

Water-sensitive techniques: include a variety of methods that aim to achieve better outcomes for water related issues. They include many techniques referred to under other names e.g. Low Impact Design (LID), Water Sensitive Urban Design (WSUD), Low Impact Urban Design and Development (LIUDD), Sustainable Urban Drainage Systems (SUDS) "natural", "green" and "sustainable" A primary aim of water-sensitive techniques is to maximise the achievement of multiple benefits rather than a single engineering technical efficiency measure.

19 References

TRIM #[41]	Document Name	Version	Date	Author
D-974909	HCC Standard Stormwater Modelling Methodology	1	1 May 2013	AECOM
-	Te Awa O Kātāpaki Catchment, Assessment of Geology, Hydrology and Gully Stability	-	March 2004	Tonkin & Taylor
-	Hamilton City Council Comprehensive Stormwater Discharge Consent 105279 2012/13 Monitoring Report	-	July 2013	Tonkin & Taylor
-	Hamilton City Council Comprehensive Stormwater Discharge Resource Consent 105279, Annual Report April 2012 to March 2013	-	-	HCC
-	Ecological Investigations of the Te Awa O Kātāpaki Stream and Catchment	-	March 2004	Kessels & Associates
-	Te Awa O Kātāpaki Integrated Catchment Management Plan – Model Build Report	-	1 April 2014	AECOM
-	Waikato Regional Council Technical Report TR 2006/25R - Environment Waikato Best Practice Guidelines for Waterway Crossings	-	2006	WRC
-	Waikato Regional Council Technical Report TR2014/29 - Appropriate use of mussel spat ropes to facilitate passage for stream organisms	-	2014	WRC
-	Gully Restoration Guide	3rd Edition	June 2006	HCC
-	Waikato Regional Council Technical Report 2007/41 - Best Practice Guidelines for Vegetation Management and In Stream Works	-	2007	WRC
-	Guidelines and Resources For Implementing Soil Quality and Depth BMP T5.13 in WDOE Stormwater Management Manual for Western Washington	-	2010 Edition	
-	Assessment of Streams and Lakes in Hamilton	-	March 2001	NIWA
-	Te Awa O Kātāpaki Stream – Assessment of Ecological Values to inform an Integrated Catchment Management Plan	-	26 May 2016	Boffa Miskell
-	Te Awa O Kātāpaki Stream – Erosion Remediation and Prevention Costing	-	19 May 2017	Morphum Environmental Ltd.
D-2798802	Review of the Erosion Issues - Te Awa o Kātāpaki Stream River Road Reach	Version 3 – Final	December 2018	Tonkin & Taylor Ltd.

[41] TRIM is the HCC data management system and document numbers are available from the HCC Project Manager.

20 Plan Index

Plan	Title
001	Catchment Boundary Plan
002	Sub-catchment Boundary Plan
003	Undeveloped Stormwater Sub-catchments Plan
004	Erosion and Stability Plan
005	Soil Types Plan
006	Erosion and Stability Monitoring Sites Plan
007	Flood Hazard Plan (based on 2008 development)
008	Topography Plan
009	Environmental Protection Overlay – Component Layers
010	Infrastructure – Water Plan
011	Infrastructure – Wastewater Plan
012	Infrastructure – Stormwater Features Plan
013	Areas to be Attenuated By Magellan Lake
018	Development Area Overland Flow Paths

Appendix A Structure Plan and Catchment Extent

Appendix B Catchment characteristics plans

Appendix C Strategic infrastructure plans

Appendix D Geology and hydrogeology

Appendix E Water quality modelling

Appendix F Three Waters requirements (Existing and Future)

Appendix G Monitoring locations plan

Appendix H Magellan Lake and Concept Plan

Appendix I Ecological Report

Appendix J Updated Ecological Findings

Appendix K TAOK Model Build Report

Appendix L Model Build Peer Review

Appendix M Stormwater Quantity Beca Memo 2021